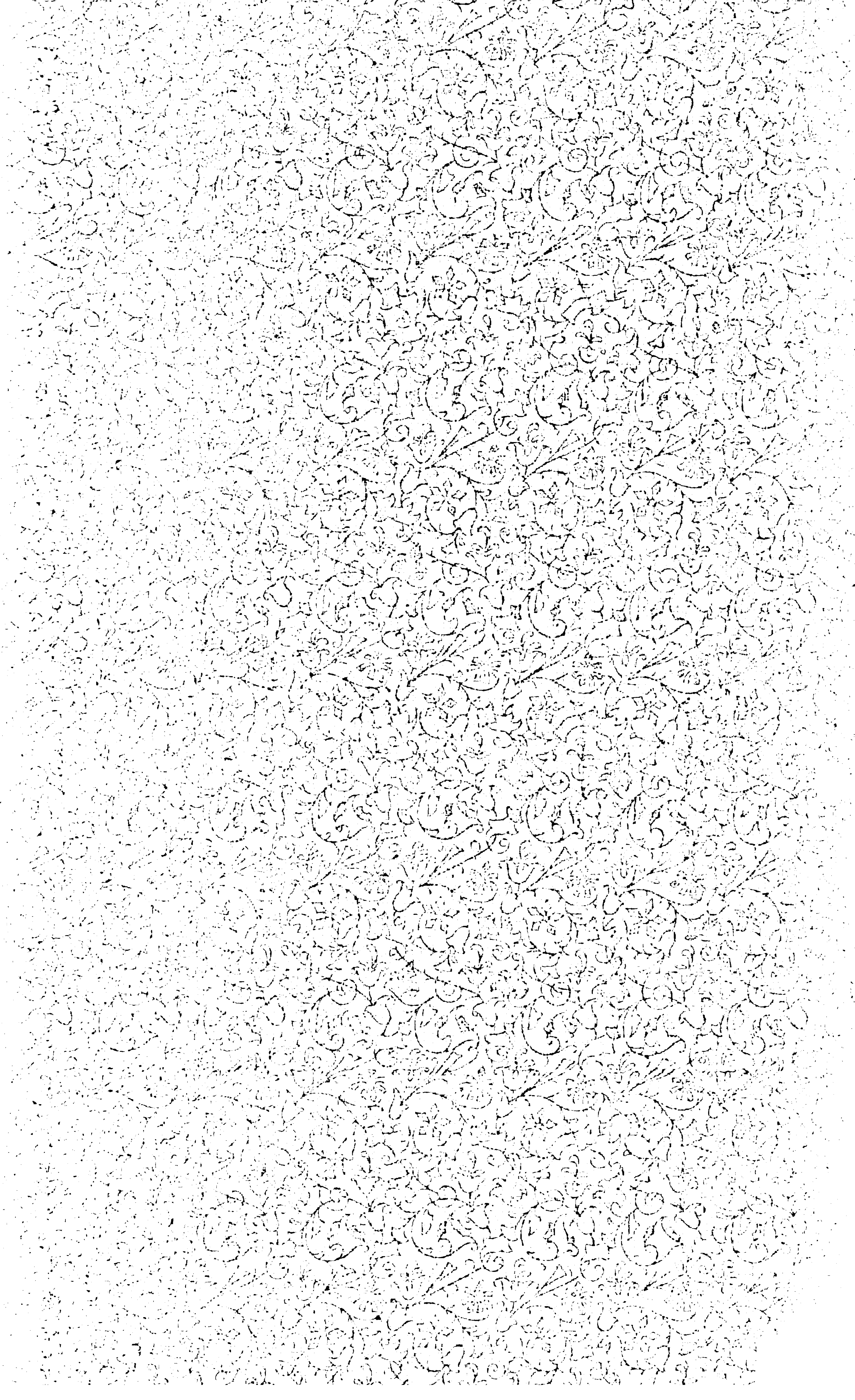

DEVELOPMENTAL PATHOLOGY

TALBOT

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BY

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MITIES OF THE HEAD, FACE, JAWS, AND TEETH."
"DEGENERACY: ITS CAUSES, SIGNS, AND RESULTS;" "INTERSTITIAL
GINGIVITIS: OR SO-CALLED PYORRHŒA ALVEOLARIS," ETC.

265 ILLUSTRATIONS

FIRST EDITION

CHICAGO

1905

To Lovers of Science,
this Work is Respectfully Dedicated.

Section I.

DEVELOPMENTAL PATHOLOGY

Laws Governing Eugenesis: A Thirty-Five Years' Study of Developmental Pathology.

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D., CHICAGO.

The views herein recorded and those advanced in "Degeneracy, Its Causes, Signs and Results"; "Osseous Deformities of the Head, Face, Jaws and Teeth"; "Irregularities of the Teeth and Interstitial Gingivitis or So-Called Pyorrhea Alveolaris," are the product of a line of research carried on for over three decades. This line of investigation was based upon the law of economy of growth governing the struggle for existence between organs (use and disuse of structures). Empedocles, 495 B. C., outlined the doctrine of evolution, including the survival of the fittest. Aristotle, 384 B. C., cleared up the relation of structures and organs to each other from the standpoint to benefit the organism as a whole. The pathology hence has been worked out upon the broad principles of development, and cause and effect have not been approached from narrow lines.

Developmental pathology is the domain of pathology which deals with departure of structures and organs from the normal along the line of arrests of fœtal evolution, either in structure or biochemic states underlying function or potentiality of development at given periods of growth. Atrophies, with or without resultant hypertrophies, or *vice versa*, are underlain by its laws.

The general trend has resulted in a working hypothesis compatible with all pathologic phenomena of the head, face, nose, jaws and teeth. With this as a guide, the student can easily study the pathologic details of any structure.

From general evolutionary principles it seems clear that those of the face, nose, jaws and teeth are the bodily structures most involved in evolutionary changes. That being the case, pathologic changes can most easily be studied and elucidated along these lines. My line of investigations since I began have therefore been along the phases of evolution in physiology and pathology. Study of diseases of the different structures of the face, nose, jaws and

teeth has been made on broader lines than those generally taught. To comprehend the pathology of these structures the laws of evolution must be understood. Evolution is that process by which an individual or structure is transformed from a lower to a higher type. Degeneration is a gradual decline of a structure in type. In the development of a man, evolution and degeneration go hand in hand. An organ or structure remains with man if it develops, or aids in the formation of a new organ; the brain is an apt illustration. Degeneration of an organ or group of organs consists in the gradual restriction or disuse of structures or their final obliteration and disappearance. The muscles of the ear, the vermiform appendix, the little toe, the false ribs, the pineal eye, but especially the face, including the nose, jaws and teeth, are peculiarly involved here.

The two terms seem at first to conflict, but man must, to suit his environment, either progress or retrograde. Progression can only take place in the struggle for existence through general development at the expense of disused organs. The structures of man are influenced greatly by environment. If he remain savage generation after generation, the surroundings being the same, he will retain, as a rule, certain fixed conditions of structure. Thus his brain will not develop, but by retention of primitive uses his jaws, by masticating coarse food, etc., will retain the size and strength of primitive life. On the other hand, if he abandon savage life, develop his brain and is not forced to masticate food, his jaws and teeth atrophy. The evolution of the negro in this country in the past two hundred and fifty years from a dolichocephalic to a mesocephalic head and from a prognathous to an orthognathous jaw peculiarly illustrate this. Man in his development from the sea-squirt passes through all vertebrate stages, from the fish and lizard to bird and mammal.

In this flight from cell to fully developed compound animal, man at the present period of his evolution has, as a result of a loss in explosive force, developed a nervous system. How well he accomplishes this development depends upon brain health. The brain of man develops first, to preside over the development of the other structures. If the brain be normal the structures of the body will develop normal; on the other hand, if from any cause the brain is abnormally developed, unstable or defective, the structures of the body become abnormal. When arrests of the brain occur

different classes of degenerates result. The more marked forms are the idiot, insane, criminal, periodical drunkard, deaf-mute and congenital blind. The one-sided genius, the habitual liar, the "smart" business man, the extreme egotist, the tramp, kleptomaniac, harlot and pauper likewise belong here. All display stigmata to a marked degree.

The structures of the nose and cavities of the face display much abnormality because of excessive and arrested development due to their transitory nature and to an unstable nervous system.

In the development of man from the primitive cell, periods of stress constituting new environment occur. Those which occur during development are called periods of evolution and those after maturity periods of involution. At these periods of stress development of the nervous system may be strained and produce arrests of development or degeneration.

Arrests which occur at any period along the line of development account for all the so-called deformities of the body, which are reversions simulating some features of the lower animals characteristic of fœtal stages through which man has passed. No structures of the body are so prone to these arrests or degenerations as the face, nose, jaws and teeth, since they are continuous in the line of evolution and are governed by the law of economy of growth in the struggle for existence between organs. This struggle for existence between organs takes place among the animals as well as man. Wild animals in captivity and other animals through domestication (change of environment and food) have changes in structures similar to that of man.

Structures undergoing arrests or degenerations are, because of lessened blood supply, more liable to disease than structures which are evolving higher. Marked illustrations of this may be found in irregularities of the teeth and disharmony in jaw development where the teeth are not being lost fast enough for the receding jaws. Interstitial gingivitis and decay are natural methods of hastening the process.

The topics here discussed originally appeared in papers read before societies and in articles published in medical and dental journals during the past two decades. The research work was first confined to the brain and the body as a whole, later the special anomalies of organs, and finally the macroscopic and microscopic pathology of these organs was passed in review. There are many

repetitions, which are beneficial since they familiarize the student with general principles or laws applied to each pathologic condition.

The object of this line of research is to simplify and make more comprehensive to teachers and students the pathology of the head, face, nose, jaws and teeth and to demonstrate therewith every pathologic condition.

Since I mapped out my line of thought and commenced my research work thirty years ago a number of books have been published along this line. That the student may more easily understand this work and broaden his education I would recommend the following to be read, in the order mentioned:

1. "Human Embryology," Minot.
2. "The Amphioxus," Arthur Willey.
3. "The Destiny of Man," John Fiske.
4. "From the Greeks to Darwin," Osborn.
5. "Evolution by Atrophy," DeMoor.
6. "Evolution and Disease," Bland Sutton.
7. "The Struggle for Existence Between Organs," Roux.
8. "Degeneracy: Its Causes, Signs and Results," E. S. Talbot.

EVOLUTION OF THE CENTRAL NERVOUS SYSTEM.

BY EUGENE S. TALBOT, M. S., D. D. S., M. D., LL.D., CHICAGO.

Man, as Nordau (Degeneration) remarks, like all complex and highly-developed living beings, is a society of simpler and of simplest living beings, of cells and cell systems or organs each having its own functions and wants. These in the course of biologic evolution have become associated and have so changed as to perform higher functions than are possible to the single cell or primitive agglomeration of cells. In order that the collective organism may be able to perform its task, its constituent parts must submit to a severe hierarchic order. Anarchy in its interior is disease, leading rapidly to death. The single cell executes its biochemic work of decomposition and integration without being obliged to trouble itself about aught else. Its power of adaptation is so minute that if a cell is in the smallest degree less well nourished than its neighbor it cannot hold its ground against the latter and is immediately devoured by it. (W. Roux, Der Kampf der Theile im Organismus, Leipzig, 1881.) The differentiated cell, group, or organ already possesses a wider consciousness, whose seat is its nerve ganglia; its function is more complex and no longer operates wholly or even chiefly for its own benefit, but for that of the collective organism. It has, so to speak, a constitutional influence on the direction of the affairs of the whole organism, asserting itself in the power of the organ to suggest to the consciousness presentations prompting the will to acts.

The most exalted organ, the condensation of all organs, is the cerebral cortex, which is the seat of clear consciousness. It works least for itself and most for the commonwealth of the whole organism. It is the government of the state. To it come all reports from the interior now as well as the exterior; it has to find its way

in the midst of all complications; it has to exercise foresight and to take into consideration not only the immediate effect of an act, but also the more remote consequences for the commonwealth. When no question of the "ego," it is not subordinated to the little toe or the rectum, but all to the cerebral cortex, to which belongs the duty of directing the individual and of prescribing its law. It is consciousness itself. But how does consciousness form its judgments and its decisions? It forms them from representations awakened in it by excitations proceeding from the internal organs and from the senses. If consciousness allows itself to be directed solely by the organic excitations, it seeks to gratify its momentary appetites on the spot, at the cost of well-being it injures an organ by favoring the need of another, and it neglects to take into consideration circumstances of the external world which must be dealt with in the interest of the whole organism.

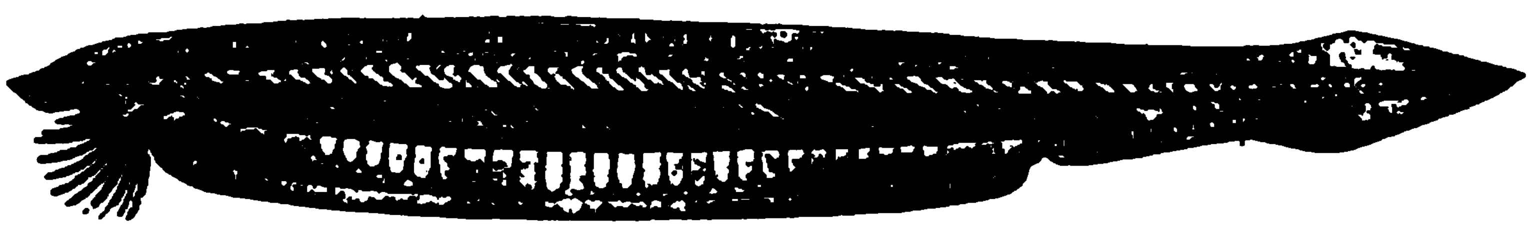
A man is swimming under water—his cells know nothing of it, and do not trouble themselves about it. They quietly absorb from the blood the oxygen which they need at the moment and set free in exchange carbon dioxid. The decomposed blood excites the medulla oblongata and the latter impetuously demands a movement of inspiration. Were the gray cerebral cortex to yield to a seemingly justifiable local demand of an organ, and allow an impulse to inspire to proceed to the muscles concerned, the lungs would fill with water and death of the entire organism result. Hence, consciousness does not obey the demand of the medulla oblongata, and instead of sending motor impulses to the intercostal muscles and those of the diaphragm, it communicates them to the muscles of the arms and legs, so instead of breathing under water the swimmer emerges at the surface. The typhoid convalescent feels a raging hunger. Were he to yield to this desire momentary satisfaction would result, but he would risk perforation of the intestines. His consciousness resists the desire of his organs for the benefit of the whole organism.

The cases are of course generally much more complex, but it is always the task of consciousness to test the stimuli which it receives from the depths of the organs, to comprise in the motor images which they excite all its earlier experiences, its knowledge, the directions given by the external world, and to disregard the stimuli if the judgments opposed to them are more powerful than

they. Even a perfectly healthy organism quickly goes to wrack and ruin if the inhibitive activity of consciousness is not exercised and if, through this want of exercise, its inhibitive strength becomes atrophied. If, however, the organism be not perfectly healthy, if it be degenerate, its ruin is much more speedy and certain when it obeys the urging of the organs. In such a case these organs suffer from either excessive or deficient use. They exact satisfaction not only pernicious in remote consequences to the organism but primarily to the organs themselves, or vice versa.

All organisms are developed cells and groups of cells. Compound organism cells retain the potentialities of single-celled organisms, which they surrender for the benefit of the whole organism. These potentialities are lighted into being by disease or disorder of the associating mechanisms constituting the checks on local

Figure 1.



—*Amphioxus Lanceolatus* from the left side, about twice natural size. (After LANKESTER.) The gonadic pouches are seen by transparency through the body-wall; the atrium is expanded so that its floor projects below the metapleural fold; the fin-chambers of the ventral fin are indicated between atriopore and anus. The dark spot at the base of the fifty-second myotome represents the anus.

action for the benefit of the cell commune or body. Cells having resumed low embryonic types for the benefit of the body retain the potentialities of the higher embryonic, which circumstances may stimulate either for the benefit of body or of the cell itself. This appears in skull and face embryogeny.

The skull is a development in part of the vertebræ and in part of dermal or membranous bones which, as in bony fish and reptiles, formed the protective armor of the skin of the head. As the head end of the spinal cord of the lancelet (amphioxus) grew (Fig. 1) in size the cartilage enclosing it developed to protect it. This was the earliest appearance of the skull in biologic as in fetal evolution. Later another skull developed in connection with this. The skull therefore has, as Minot remarks (Embryology, p. 465), a double origin, or, rather, there are two skulls which were originally distinct. In evolution from the lowest fish to the highest

mammal, and in the embryonic development of man, these become united.

The primary skull is an extension of the vertebræ which send side-outgrowths to cover the brain, as the backbone covers the spinal cord. This primary skull (Fig. 2) extended in front of the notochord (the spinal cord of the human embryo and the permanent spinal cord of the lancelet—amphioxus—or prevertebrate ascidan). In the lancelet it gave off two trabeculæ cranii or front skull plates. In back the primary skull (or chondrocranium) gives off (Fig. 3) two occipital or rear skull plates and two plates midway between the trabeculæ and occipitals. [NOTE.—"In describing this figure in detail," says Minot, "there is one remark to

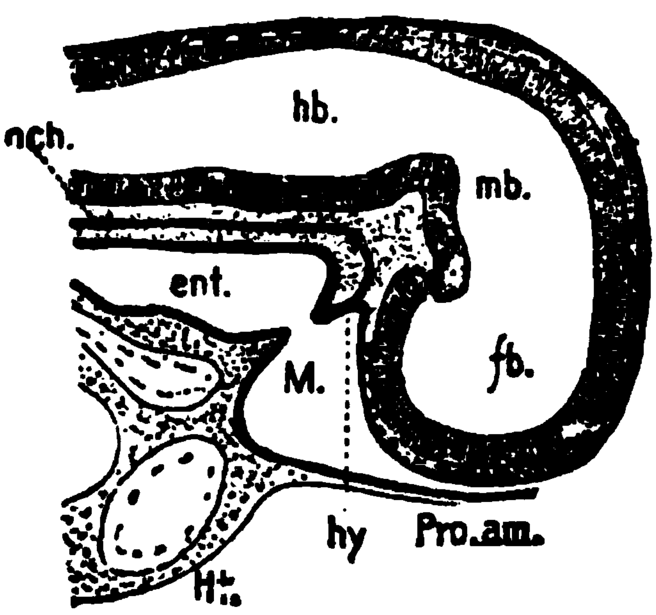


Figure 2.—Rabbit Embryo of 6 mm.; Median longitudinal Section of the Head. The connection between the mouth, M, and pharynx, ent, is just established; nch, notochord; hb, bind-brain; mb, mid-brain; fb, fore-brain; pro. am., proamnion; hy, hypophysis cerebri; ht, heart. After Mihalkovics.

be made, namely, that here we have clearly shown the true *diagnostic mark* of a mammalian skull. This mark is the rupture of the side walls, due to the pressure of the large lateral masses of the cerebrum. In front of the auditory capsules there is a large semicircular opening, the crown of the arch looking upward and forward. Only the lower half of the wall has thus broken outward; this "fault" forms the alisphenoid, while the orbitosphenoid (o. s), the so-called "lesser wing," is many times its size and is continuous over the archways with the cartilage that runs on backward into the supraoccipital region (s. o.). There is nothing similar to this in that sauropsidan skull which comes nearest to that of the mammal—the skull of the crocodile (See Trans. Zool. Soc., Vol. XI, Plate 65), while in birds the orbitosphenoids are very small, even when they are most developed, as in struthio (see Phil. Trans.,

1866, Plate 7), and in that class the alisphenoids almost finish the cranial cavity, being turned inward toward each other, on each side of the back part of the orbital septum. I lay special stress upon this rupture outward of the alisphenoid, and on the fact that the nasal roofs utilize the whole of the huge high-crested intertrabecula, because these are the most distinctive marks of the mammalian skull and they arise from two things in which the mammal shows its great superiority to even the highest sauropsida, namely, the huge volume of the cerebrum and the tenfold complexity of the nasal labyrinth. A third clear diagnostic sign is seen in this very figure—this is the peculiar development of the antero-inferior part of the oblique auditory capsule, due to the development of the

Figure 3.—Chondrocranium of an Insectivorus Mammal. (Tatusia). After W. K. Parker.

coils of the cochlea. So that, at once, correlated with the sudden expansion, so to speak, of the cerebrum, we have these new and most important improvements in the organs of smell and hearing. At first sight, seeing how large the median bar (intertrabecula) is, with its internasal crest (perpendicular ethmoid and septum nasi—p. e., s. n.), it might be supposed that the mammalian skull was of the high kind, like that seen in many teleostean fishes, lizards and in birds. It is not so, however, but belongs to the low kind, seen in selachians and amphibians, and, like theirs, is hinged on the spine by a pair of occipital condyles. Hence, the eyeballs are kept far apart, instead of coming very near each other, as in most birds, where often nothing but a membranous fenestra is found between the right and left capsules and their special muscular apparatus. But the face as well as the skull of the mammal shows marks

of excellence such as are not seen in the sauropsida, even in the higher kinds, as crocodiles and birds. The great development of the nasal organs is correlated with a most remarkable growth of the bones of the upper jaw and the palate to form the "hard palate." This is found in rudiment even in the chelonia and in birds, but especially in the crocodilia, where, however, its excessive development—as in certain edentata, e. g., myrmecophaga—is not dependent upon or correlated with any great improvement in the organs of smell, but has to do with the peculiar manner in which these monsters take their prey."] These gradually inclose the primitive hearing apparatus, the otocysts (permanent in fish and embryonic in man), and are called periotic capsules.

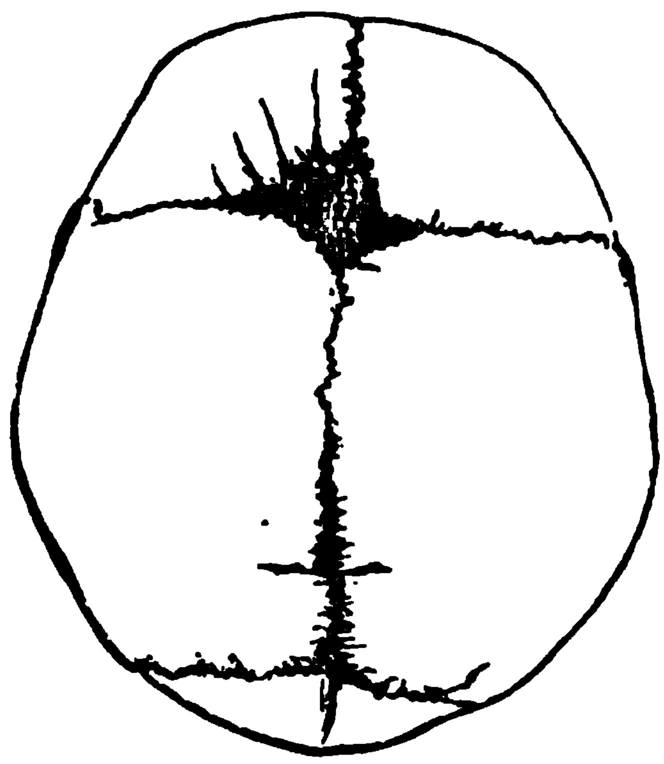


Figure 4.—Skull showing fontanelles. Gray.

This primary skull is at first cartilaginous, as in sharks. With the increase in the size of the brain in biologic evolution and in human embryogeny, this cartilaginous primary skull becomes insufficient to roof over the brain and gaps result. The fontanelles (Fig. 4) or soft places at the top, sides and back of the head of the new-born are expressions of this failure of the primary skull to cover the gains of the nervous system. This deficiency, while resultant on certain advances in evolution, would be a serious block to further advance or to life itself were it not that the fetal skin of all mammals retains an osteogenic function normal in reptiles, certain edentates and bony fish.

These cavities were filled by dermal bones (Fig. 5), which first served merely as armor in the skin of the head, but later came to be protectors of the nervous system. The following are representative

dermal bones in the embryonic human skull: The frontals, which form the chief part of the forehead. The sutures or dovetails of these normally disappear in the adult, so that the forehead seems to be but one bone. This union may not occur (Fig. 6), as in the case of the philosopher, Kant, who had a frontal suture all his life. The dovetails are replaced by solid bone through a process called synostosis. In the case of the frontal bone it is normal and

Figure 5.—Lateral view of skull, showing wormian bones. Charles A. Parker.

in the line of advance. Elsewhere in the skull it expresses defect, giving rise to various cranial states either absolutely degenerate in type or degenerate in certain races only. The parietals and inter-parietals are dermal bones united by synostosis to form the parietals or side bones of the adult human skull. The nasal bones (which together with the vomer form the nose) are dermal bones and so are the pterygoids and palatines. The maxillaries and premaxillaries (which with the mandibles form the jaws) are der-

mal bones. The mandibles are in part derived from the chondrocranium.

With rise in evolution and during the progress of human embryonic development these bones become fewer through their early cartilaginous union or synostosis. The openings in the skull resultant on the deficiencies in the chondrocranium are larger in the

Figure 6.—Front view of skull, showing open suture in center of frontal bones. Charles A. Parker.

sauropsida (birds and reptiles) than in the ichthyopsida (amphibians and fish), in the monotremata (egg-laying mammals) than in the sauropsida, in the marsupials (pouched mammals) than in the monotrema, and in the higher mammals than in the marsupials. Brain development therefore depends on the expanding power of the secondary skull formed by the dermal bones. These are degenerate bones, a mere reminiscence of that outer skeleton whereby

early fish and reptiles emulated the lobster. Any check to development which produces organism degeneracy is exerted on bone development itself and finally on the relation to other bones or dovetailing.

In accordance with the laws of growth, deficiency in one place usually results in increase elsewhere. The brain-protective function of the dermal bones, being later in development than their old armor function, is checked by degeneracy in two ways—either the bone does not grow in size sufficiently to unite with its fellows, or this growth occurs for benefit of the bone alone, and therefore that union with other bones occurs too early to benefit the organism as a whole. To the factors underlying this is due that failure of increase in intellect after puberty which appears in the higher apes and in some of the lower human races. These checks likewise tend to nutritional benefit of the older primary skull, whence result irregularities in development that constitute so many skull stigmata. The sutures sometimes do not form because sufficient cartilage is not produced to fill the gaps (Fig. 4). These secondary gaps are often filled by new dermal bones called wormian. Sometimes this deficiency coexists with too early synostosis elsewhere.

The development of the face depends upon enlargement and fusion of the mouth and nose cavities, and upon later partial separation of nose and mouth and nose cavities, leaving the posterior nose open. It depends further upon the growth and specialization of the face region, of which the elongation is the most prominent indication, and finally upon the development of a prominent nose. When the medullary tube of the notochord enlarges to form the brain the end of the head bends over to make room for that enlargement (Fig. 2). The bending of the head carries the mouth plate, which is to be the mouth, over to the front of the head. What develops the mouth cavity is the growth of the brain and the increase in size of the heart cavity, which expand to the front, leaving the mouth cavity between them. The mouth cavity represents two gill slits united in the front line. The nose (Fig. 7) is formed from two olfactory plates situated just in front of the mouth and in contact with the fore-brain. These olfactory plates grow in size by the increase in tissue and the resulting pits pass

away from the brain. At first these pits, although separated by what is called the nasal process, communicated freely with the mouth. The nasal process includes the origin of the future nose and of the future intermaxillary region of the upper lip.

The human face modified backward from the vertebrate type illustrates once more degeneracy of a series of related structures for the benefit of the organism as a whole.

Struggle for existence between the organs implies the creation

Figure 7.—Reconstruction of the Face of His. Embryo Sch. N. of, olfactory nerve, Nn, nasal cavity; R. T., Rathke's pocket; Ch, notochord; T, tonsil; P. g., processus globularis; Gl, palate anlage; Uk, mandible. After W. His.

of potentialities which must not only be inherited but must pass through periods when the newer type has to compete with organs already existing. There must therefore be the usual excess of material for growth, like that which occurs in fractures, where provisional callus is thrown out. This needful excess is obtained at the expense of other organs. If utilization of disappearing fetal organs suffices to provide this defects do not occur. If otherwise, they occur along the line of least resistance, which may be the higher or lower gains.

Since certain parts may disappear in the evolution of organs,

and certain organs during the evolution of organisms, and since the disappearance and developing tendency must center around the time when certain functions will be lost by the disappearing and others gained by the developing periods of stress must occur, around which the law of economy of growth will center, the struggle for existence between the parts of organs and between organs. Struggles for existence on the part of the different organs and systems of the body are hence most ardent during the periods of intra and extrauterine evolution and involution. During the first dentition, during the second dentition (often as late as the thirteenth year), during puberty

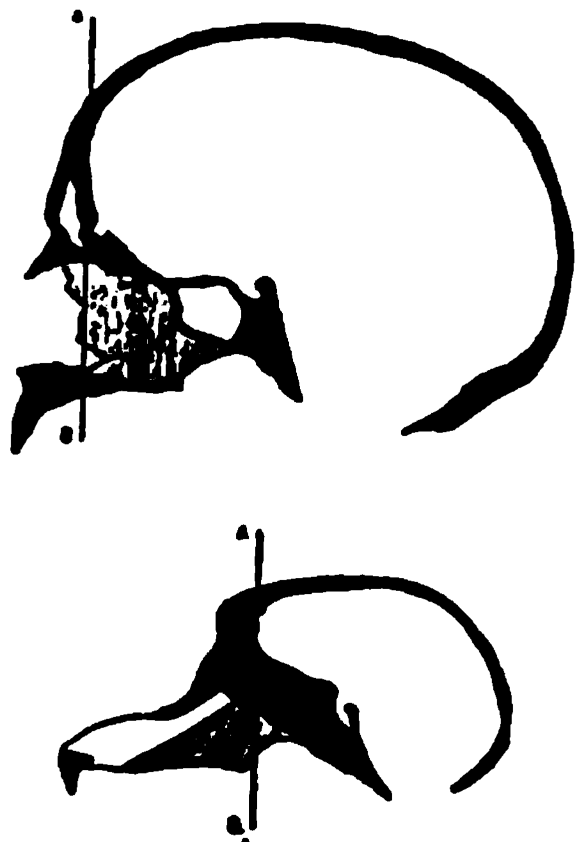


Figure 8.—Upper, human skull; lower, skull of Anthropoid Ape, showing human brain development at the expense of the jaws.

and adolescence (fourteen to twenty-five), during the climacteric (forty to sixty), when uterine involution occurs in woman and prostatic involution in man, and finally during senility (sixty and upwards) mental or physical defects may, as I have elsewhere shown, occur, a congenital tendency to which has remained latent until the period of stress.

When systemic balance, the result of evolution, is disturbed by change in environment, the organs, as has been shown experimentally, do not pursue their usual growth. Such disturbances are peculiarly apt to occur during periods of stress because of the then varying relations of different organs.

During the first extrauterine period of stress, between birth and three months, the brain is one-fifth the weight of the body, while

in the adult it is but one thirty-third. During the first six months the brain doubles in weight. The effects of stress during this period would, under the law of economy of growth, be felt either in diminution of the quality or quantity of the brain or in the preservation of these at the expense of more transitory structures. Here the teeth, alveolar process and jaws would be affected. In other words, when a given amount of nutriment is sent to the head there is a struggle between the face, jaws and teeth and the brain for the material, as observed in Fig. 8. If the jaws succeed in obtaining the most there is a return to the anthropoid, as observed in the lower figure, the brain case becomes smaller and the jaws larger. On the other hand,

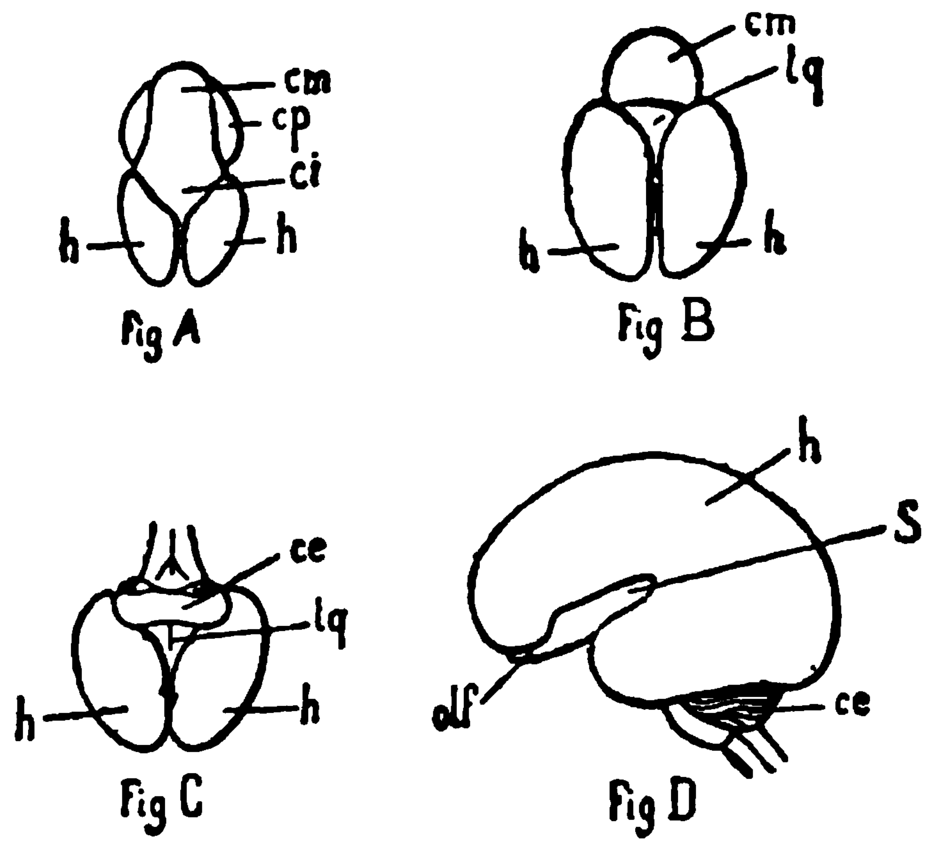


Figure 9.—A, Brain of a human embryo of seven weeks; h, cerebral hemispheres; ci, intermediate brain or thalamencephalon; cm, mid-brain; cp, hind-brain. B, Brain of human embryo about the beginning of the third month; h, cerebral hemispheres; tq, region of the corpora quadrigemina; cm, mid-brain. C, Brain of a human embryo at the middle of the third month; h, cerebral hemispheres; tq, corpora quadrigemina; ce, cerebellum. D, Human brain of the fifth embryonic month; h, cerebral hemispheres; olf, olfactory lobes; S, fissure of Sylvius; ce, cerebellum. (After Mihalkovics Entwickelungsgeschichte des Gehirns. Leipzig, 1877.)

if the brain receives the most nutriment the brain and skull develop at the expense of the jaws, as observed in the upper figure and in Fig. 5. During the period between two years and six the same factors to a lesser degree are present, while between seven and fourteen the brain has quadrupled in weight.

At birth the heart is small relatively to the arterial system, but this disproportion gradually disappears until puberty when, according to Beneke, the relation is changed. The larger the heart relatively to the vessels, the higher the blood pressure and the earlier, stronger and more complete is the development of puberty. The weight of

the heart from birth increases twelve and a half times.. During this period strain interfering with heart growth would either affect it or, under the law of economy of growth, the more transitory structures for its benefit.

To a certain extent periods of stress resemble ancestral stages. Moreover, when there is a recapitulation of ancestral stages it often happens that evolution takes place without leaving traces of the various stages. This is especially the case in complex organs which

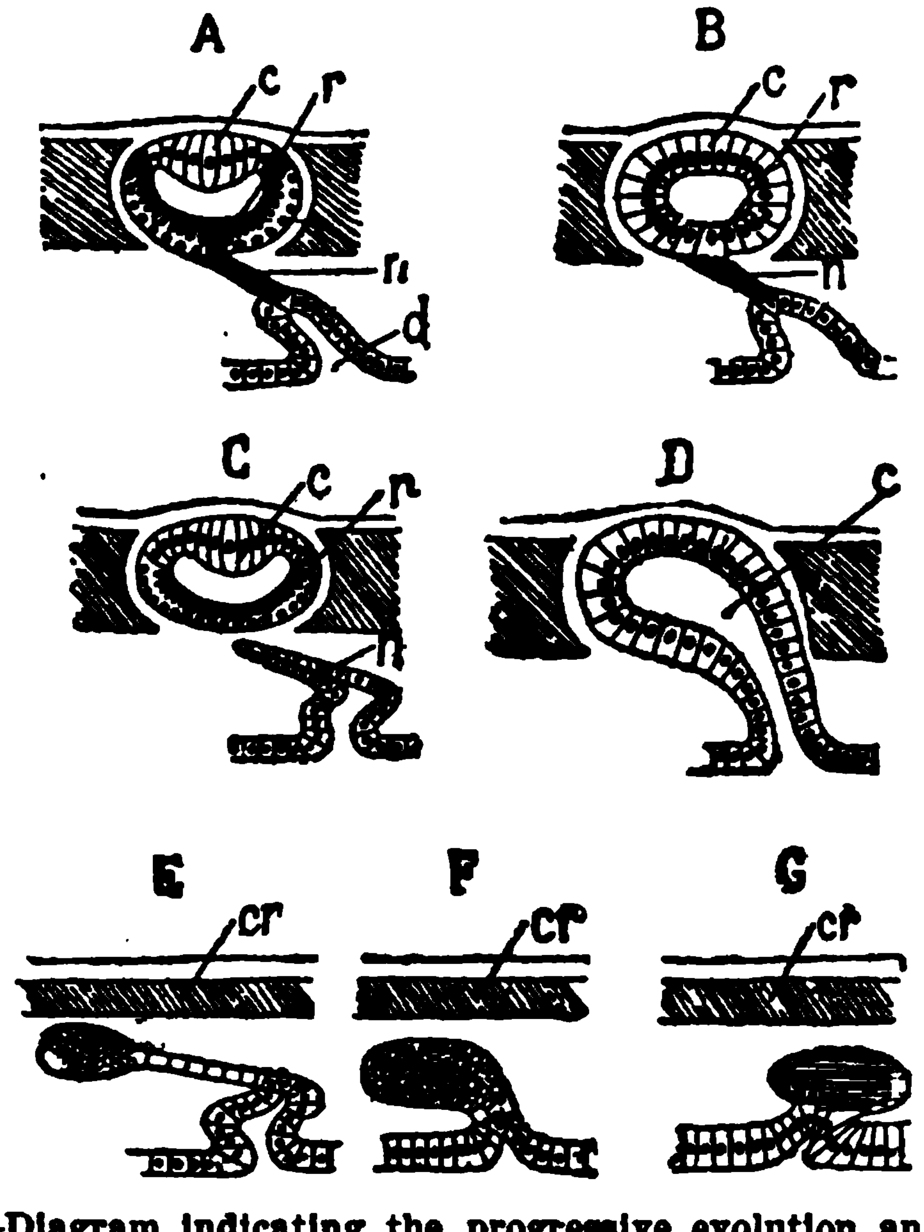


Figure 10.—Diagram indicating the progressive evolution and the degeneration of the pineal eye. A, Perfect pineal eye, as found in the slow worm before birth, or in the adult Sphenodon (Hatteria); c, lens; r, retina; n, optic nerve; d, divertialum of the thalamencephalon. B, Pineal eye in first stage of degeneration as it exists in Chamæleo and as it was in the slow worm before stage A. The lens (c) and the retina (r) are not differentiated. C, Pineal eye in the degenerate form found in Calotes and Leiodera; c, lens; r, retina; n, optic nerve in fatty degeneration. D, Very degenerate pineal eye, as in Cyclodus and like the earliest stage in the slow worm; there is no differentiation of the divertialum from the thalamencephalon. E, F, G, Other modes of degeneration of the pineal eye. The eye lies within the skull, and there is no parietal foramen; cr, cranial membranes. E, Ceratophora. F, Birds. G, Mammals. (After Baldwin Spencer.)

have been produced by many lines of evolution converging in a single structure—a structure which thus becomes the seat of a special function or set of functions.

The neuron, for instance, the ganglionic cell of the cortex, passes successively through stages corresponding to those which are to be found in the adult fish, frog, bird and mammal. Here development

consists in an increasing complexity of the cell with no formation of unnecessary rudimentary parts. This is also the case when the development of the brain of man is compared with the probable ancestral stages as displayed in the vertebrate series (Fig. 9).

In Fish and Batrachia,
The cerebral hemispheres do not cover the region of the third ventricle (thalamencephalon) from which the eyes arise.

In the Human,
Same embryo of aspects the seventh week.

Figure 11.—Human cyclops.

In Reptiles,
The hemispheres cover the thalamencephalon, but leave the region of the optic lobes (mesencephalon).

In the Human,
Same embryo of aspect the middle of the third month.

In Mammals,
The hemispheres cover the thalamencephalon, the mesencephalon, sometimes the metencephalon (cerebellum and medulla) and the olfactory lobes.

In the Human,
Same embryo of aspect the fifth month.

In the same mammals even of higher orders (e. g., some hapalidæ),	In the Human, Same embryo of aspect the middle of the fifth month.

The hemispheres are smooth.

Perhaps the most striking instance of the sacrifice of an organ in local degeneracy for the benefit of the body as a whole occurs in the case of the pineal body. This undergoes the steps depicted in Fig. 10 for the benefit of the two eyes and the body. In the human cyclops (Fig. 11) the procedure is reversed; the median eye which becomes the pineal body develops at the expense of the two eyes and the general nervous system.

Each nerve and nerve group is endowed with motor, sensory and trophic powers, hence with increased development the force underlying these powers is distributed among more groups by a system of balance which prevents explosive tendencies. The growth of checks hence constitutes advance.

UNDERLYING FACTORS OF DEVELOPMENTAL PATHOLOGY.

BY EUGENE S. TALBOT, M. S., D. D. S., M. D., LL. D., CHICAGO.

Since in the evolution of organs certain parts disappear, and in the evolution of organisms certain organs are sacrificed through suppressive economy, since also the disappearing and developing tendencies necessarily center around the time when functions are to be lost by the disappearing and others gained by the developing, periods of stress occur Around these the law of economy of growth centers. the struggle for existence between parts of organs themselves (Kiernan, *Medicine,* 1901), and because of this fact physiologic atrophies and hypertrophies and their reverse occur. Almost every physiologic disturbance may result at these periods of stress from the influence of maternal nutrition or environment or hereditary factors.

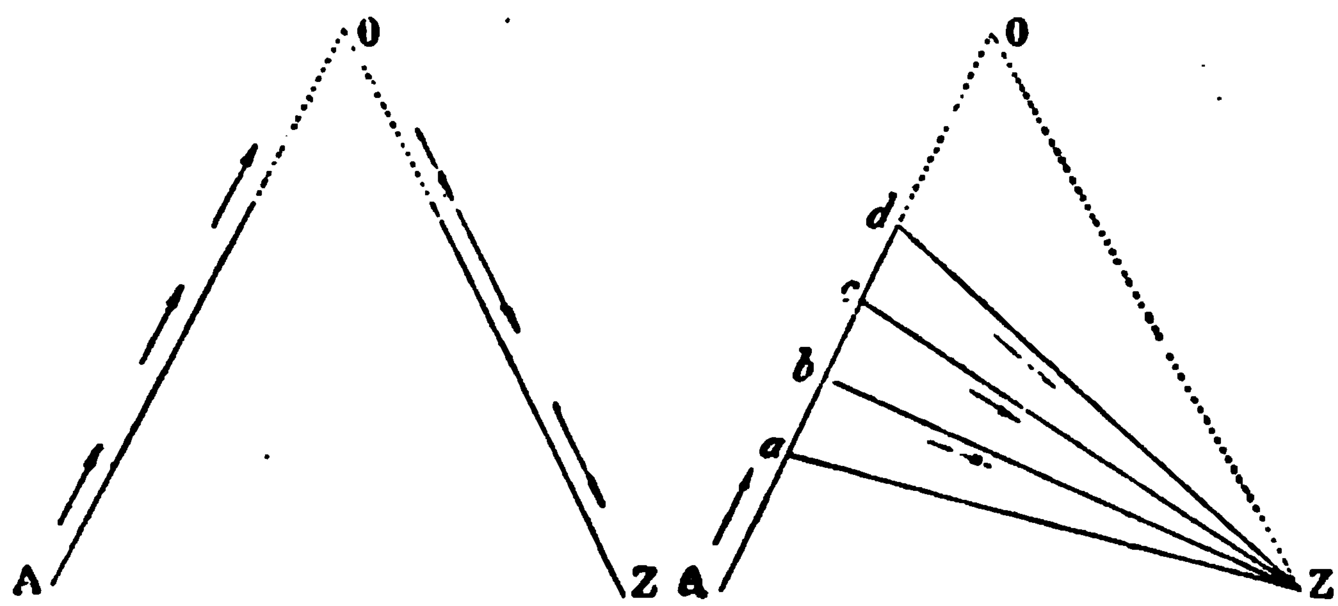
Because of the reverse phase of physiologic atrophies and hypertrophies, Morgan and Legrain made the true but too positive assumption that degenerates are abnormal because of the inability to reacquire progressive powers of primitive ancestors. There are here two factors independent of the enormous one of environment to be considered—the impetus given nutrition toward the degenerating hypertrophied organ and the impetus of nutriment from the atrophied organ. For this reason retrogressive evolution involves more than the simple retracing steps. These elements are illustrated in the diagrams of Morgan and Legrain. The ascending lines represent the progressive evolution of an organ or institution; the descending lines represent the degenerative or suppressive evolution. From the point a, representing the primitive condition, progressive evolution passes toward o, an imaginary perfect condition of the organ. Along the upward line, however, the points a, b, c, d, etc., represent obstacles to further progress—that is to say, factors

tending towards degeneration. From these points lines of degeneration pass towards z, and the condition at z, although representing that at a, is not indentical with a, and is not reached by a sliding backwards down the line O-A. Thus, while most recently acquired features tend to disappear first, degeneration is not a complete retracing of steps until the point of departure is reached.

The obstacles to further progressive evolution, or causes which underlie developmental pathology (degenerations or arrests of development), are, in the order of their severity, excesses of all kinds, including those in toxic agents, contagious and infectious diseases, heredity, consanguineous and neurotic marriages, school strain, or neurasthenia from any cause in parents. As these causes have been discussed in my various productions (Degeneracy: Its Causes, Signs and Results. Irregularities of the Teeth. Interstitial Gingivitis or So-called Pyorrhea Alveolaris) they will not be considered in detail here. Agencies which produce neurasthenia or fagged-out nervous systems are divisible into the following groups: those embracing condiments, medicines, foods and beverages, those arising from occupations and excessive indulgence, and those from resultant worries and uncertainties.

Tobacco is the most common, while alcohol and opium contend for second place both as to use and deleterious effects. Alcohol has been repeatedly charged with being the greatest factor in degeneracy. The influence of alcohol on the individual must first be studied to determine its potency and method of action as a cause of race deterioration. Careful medical researches have shown that alcohol produces a nervous state closely resembling that induced by the contagions and infections, and often accompanied by mental disturbance. The acute nervous state to which the term "alcoholism" was applied by Magnus Huss has all the essential characteristics of the nervous state due to the contagions and infections or mental exhaustion. The action of alcohol may be limited to the central nervous system and thus produce hereditary loss of power. It may cause changes or degeneracies in the peripheral nerves which in the offspring find expression in spinal cord and brain disorder through extension of the morbid process. But for its deteriorating effects on the ovaries and testicles alcohol would be a most serious social danger. Through these, however, it tends to prevent the survival of the unfit rather than to develop degeneracy.

Opium seems to be the Charybdis on which the human bark strikes when escaped from the Scylla of alcohol. Its abuse as a narcotic is much older than is generally suspected even among the English-speaking races. Murrell over ten years ago demonstrated that the inhabitants of the Lincolnshire fens had long employed opium as a prophylactic against malaria. The ratio of insanity in these regions proved to be very great. The same conditions obtained in certain malarial regions of New Jersey and Pennsylvania, where the use of strong infusions of the poppy was common. The statistics of Rush (Observations on the Brain and Mind. Page 10, 1798) as to opium-caused insanity in Pennsylvania indicate that the percentage of American opium abuses at the beginning of the nineteenth century was very great. The drug differs in two impor-



tant aspects from alcohol—it is nearer in chemical composition to nerve tissue, and the tendency to its use may be transmitted by the mother directly to the fetus, since it passes through the placenta very often unaltered. Opium is a more dangerous factor of degeneracy than alcohol, since the opium habitué must be in a continuous state of intoxication to carry on his usual avocation, while abstinence from alcohol is perfectly compatible with proper work on the part of the alcoholist. The opium habit is increased by the propaganda carried on by the habitués, who justify their position by urging the use of opium for any ailment, however trifling. Opium like alcohol causes nervous exhaustion similar to but greater than that of the contagions and infections. From the affinity of opium to nerve tissue; from its tendency to stimulate the heart, thus causing increased blood supply to the brain; from its action on the bowels and the increased resultant work of the liver, this nervous state is much intensified. Opium does not interfere with the structure and

fecundation of the ovary and testicles like alcohol, hence the danger of the opium habitué's children surviving. Opium when smoked stimulates the reproductive apparatus and thus greatly increases the number of degenerates due to this habit, although the defects due to the inheritance of the habit and their consequences lessen survivals.

With tobacco, as with alcohol and opium, the statistic method generally proves fallacious when applied to degenerative effects. The most careful researches show that the typical effects occur as a rule after long continued use of tobacco, sometimes not until twenty years or more. While many smokers reach old age, many fail to live to old age because they are smokers. The skin is subject to itching and reddening; the nerves of taste are blunted and patches develop in the throat; loss of appetite, epigastric fulness, pain, vomiting and disturbance of bowel function are common. Menstrual disturbance occurs in women, and in female cigar-makers abortion and pluriparity are frequent. The sexual appetite is impaired, and sometimes sterility and impotence occur. Disturbed heart action, palpitation, rapid and intermitting pulse, precordial anxiety, weakness, faintness and collapse, with sclerosis of the coronary arteries of the heart and left ventricular hypertrophy occur often. Cigars and cigarets produce irritation of the nose and mucous membrane, diminished smell, chronic hyperemia of the epiglottis and larynx, and sometimes of the trachea and bronchi, predisposing to tubercular infection. Nicotine amblyopia is common, with central disturbances of the field of vision and slight color blindness. Often there is disorder of the ear tubes and congestion of the drum, with loss of auditory power and consequent noises in the ear. The central nervous system is affected. In high schools nonsmokers progress faster than smokers. Child smokers from nine to fifteen years of age exhibit less intelligence and more laziness or other degenerative tendencies. Adults have head pressure, sleeplessness or drowsy stupor, depression, apathy and dizziness. There may also be ataxic symptoms, paretic weakness of bowels and bladder, trembling and spasms. Tobacco insanities, though comparatively rare in smokers, are common in snuffers and still more so in chewers. (Annual of the Universal Medical Sciences, 1895). In the precursory stage, which lasts about three months, there are general uneasiness, restlessness, anxiety, sleeplessness, and mental

depression, often of a religious type. After this occurs precordial anxiety, and finally the psychosis proper, consisting of three stages: 1. Hallucinations of all the senses, suicidal tendencies, depression, attacks of fright, with tendency to violence and insomnia. 2. Exhilaration, slight emotional exaltation, with agreeable hallucinations after from two to four weeks' relaxation, again followed by excitement. 3. The intervals between exaltation and depression diminish, and the patient becomes irritable, but otherwise not alive to his surroundings. Perception and attention are lessened. The patient may be cured in five or six months if he stops tobacco during the first stage. In a year or so he may recover during the second stage. After the third stage he is frequently incurable. As the patient often becomes (especially by the use of the cigaret) an habitué before puberty, the proper development and balance of the sexual and intellectual system is checked. These patients break down mentally and physically between fourteen and twenty-five. The moral delinquencies, other than sexual, are often an especial tendency to forgery and deceit of parents. Frequently the insanity of puberty (hebephrenia) is precipitated by tobacco. The cigaret if used moderately may be a sedative, but as used is a stimulant, and is often made of spoiled tobacco, resembling in reaction morphine, and acting on animals in a somewhat similar manner. As tobacco turns the salivary glands into excretory glands, it leads to imperfect digestion of starch and to consequent irregular fermentation in the bowels, thus at once furnishing a culture medium for microbes, from which to form more violent toxins, and likewise creating leucomaines, to damage a nervous system overstimulated by nicotine. This is one great reason why those who use snuff and chew tobacco become insane more frequently than smokers, albeit these last are not exempt.

Statistics from the female employes of the Spanish, French, Cuban and American tobacco factories, while defective and somewhat vitiated by the coexistence of other conditions producing degeneracy, support the opinion that the maternal tobacco habit (whether intentional or the result of an atmosphere consequent on occupation) is the cause of frequent miscarriage, of high infantile mortality, of defective children, and of infantile convulsions. Tobacco, therefore, in its influence on the paternal and maternal organism, exhausts the nervous system so as to produce an acquired transmissible neurosis.

Professional tea-tasters have long been known to suffer from nervous symptoms. Very early in the practice of their occupation the head-pressure symptoms of neurasthenia appear. Tremor also occurs early. While changes in the optic nerve have not been demonstrated beyond a doubt, still eye disorders have been observed in the pauper tea-drinkers of the United States and in the tea-tasters of Russia, indicating similar changes to those produced by tobacco and alcohol. The tea-cigaret habit has these effects. Bullard (Annual of the Universal Medical Sciences, 1889) finds that tea has a cumulative effect. In his experience toxic effects are not produced by less than five cups daily. The symptoms manifested are those of nervous excitement resembling hysteria, at times almost amounting to fury; nervous dyspepsia; rapid irregular heart action; heart neuralgia; helmet-like sensation and tenderness along the spine. James Wood of Brooklyn (*Ibid.* 1895) found that ten per cent of those under treatment at the city hospitals exhibited similar symptoms. Of these sixty-nine per cent were females, and every symptom ascribed by Bullard to tea was seen by Wood in his cases, who also found that the women manifested irregularities in menstruation of neurasthenic or hysterical type. He found that these symptoms were produced by one-half of the quantity of tea charged with these effects by Bullard. The *Lancet* several years ago, from an editorial analysis of the effects of tea-tippling, took the position that in no small degree nervous symptoms occurring in children during infancy were due to the practice of the mothers both of the working and society class indulging in the excessive use of tea, the excess being judged by its effects on the individual and not by the amount taken. Convulsions and resultant infantile paralysis were frequently noticed among the children of these tea-tipplers. Observations among the factory population and the workers in the clothing sweat-shops show that tea neurasthenia, presenting all the ordinary symptoms of nervous exhaustion, is especially common. It is evident that tea produces a grave form of neurasthenia readily transmissible to descendants. In addition to its effects directly upon the nervous system, tea tends to check both stomach and bowel digestion, and this increases the self-poisoning which is so prominent a cause, consequence and aggravation of these nervous conditions.

Coffee exerts an action very similar to that of tea, although the

nervous symptoms produced by it are usually secondary to the disturbances of the stomach and bowel digestion. Coffee produces tremor, especially of the hands, insomnia, nervous dyspepsia and helmet sensations. With the exception of certain districts of the United States coffee abuse is not carried to such an extent as tea, albeit in these, as in some portions of Germany, the habit is an excessive one. The conditions described result in Germany as frequently as they do in the United States. Mendel (*Neurologisches Centralblatt* 1887) finds that in Germany coffee inebriety is increasing and supplanting alcohol. Profound depression with sleeplessness and frequent cortex headache are early symptoms. Strong coffee will remove these temporarily, but it soon loses its effect and they recur. The heart's action is rapid and irregular, and nervous dyspepsia is frequent. L. Bremer of St. Louis has observed similar conditions among both Germans and Americans there.

While coca took its place but recently among the toxic causes of degeneracy, it was a factor of Peruvian degeneration long ere the discovery of America. Forty-three years ago (Johnson, Chemistry of Common Life, Vol. II.) Europeans or people of European origin in different parts of Peru had fallen into the coca abuse. A confirmed chewer of coca, called a coquero, becomes more thoroughly a slave to the leaf than the inveterate drunkard is to alcohol. Sometimes the coquero is overtaken by an irresistible craving and betakes himself for days together to the woods and there indulges unrestrainedly in coca. Young men of the best families of Peru are considered incurable when addicted to this extreme degree, and they abandon white society and live in the woods or in Indian villages. In Peru the term "white coquero" is used in the same sense as irreclaimable drunkard. The inveterate coquero has an unsteady gait, yellow skin, quivering lips, hesitant speech and general apathy. The drug has assumed an unusual prominence in the field of degeneracy since the discovery of its alkaloid, cocain. In both Europe and the English-speaking countries the world over a habit has resulted which, while much overestimated, is undoubtedly growing and aggravating as well as producing degeneracy. Many of the cases reported as due to cocain are, however, chargeable to the craving of the hysteric or neurasthenic to secure a new sensation, or the desire on the part of the opium or whisky fiend to try a dodge for forgiveness by friends. The habit is very frequently induced

by patent medicines taken to cure catarrh by the neurasthenic or to cure nervousness by hysterics as well. As deformities of the nose passages predispose to "catarrh," patent medicines for local application containing cocain are frequently employed in the treatment of this supposed constitutional disease, with the result of aggravating the original degeneracy. The youth under stress of puberty frequently ascribes all his ills to catarrh, and for it often employs snuffs containing cocain, and his nervous condition is much aggravated thereby. Among the nostrums urged in the newspapers and magazines for this condition so often resultant on nerve stress alone is a snuff containing three per cent of cocain. From the description given by Johnson of the coquero there can be no doubt that tramps, errabund lunatics and paupers result from this habit to give birth to degenerates in the next generation.

Lead produces in those exposed to its fumes a systemic nervous exhaustion, characterized by local paralysis about the wrist, as well as the general symptoms of profound systemic nerve tire. This may result, as was pointed out nearly half a century ago (Tanquerel des Planches, Lead Diseases, American Edition, 1848), in acute insanity of the confusional type followed very often by mental disorder of a chronic type resembling paretic dementia. In some cases the patient recovers from the acute insanity to suffer thereafter from epilepsy. In other cases (Kiernan, Journal of Nervous and Mental Diseases, 1881) an irritable suspicional condition also results, in which the patient may live for years, marry and leave offspring. This last condition and the epileptic are the most dangerous as to the production of degeneracy. The women employed in the pottery factories in Germany suffer, according to Rennert (American Journal of Obstetrics, Oct., 1882), from a form of lead-poisoning which produces decidedly degenerative effects upon the offspring. These women have frequent abortions, often produce deaf-mutes and very frequently macrocephalic children.

Brass-workers suffer from a nervous condition very similar to that produced by lead. Hogden (Birmingham Medical Review, Jan. 1887) of Birmingham and Moyer (Medicine, May, 1904) have called attention to the grave forms of nervous exhaustion produced among brass-workers. The period during which the patient is able to pursue the occupation without breaking down is longer than that of the lead-workers. Women, like men, are exposed to

this condition. The chief effects produced, so far as the offspring have been observed, are frequent abortions and infantile paralysis.

The occupations exposing to mercury, whether mining, mirror-making or gilding, produce forms of systemic nervous exhaustion in which the most marked symptom (but less important from a sanitary standpoint) is a tremor amounting at times almost to the shaking palsy. Like all other systemic nervous exhaustions, the mercurial one may appear as degeneracy in the offspring. The employment of women in match factories and tenement-house sweat-shops is growing. The chief toxic effect of phosphorus is not the localized jaw necrosis. This is but an evidence of the progressive system saturation with phosphorus, and bears the same relation to the more dangerous effects of phosphorus that "blue gum" does to the systemic effects of lead.

Every condition of toxic origin capable of producing profound systemic nervous exhaustion in the ancestor, and especially in the ancestress, may induce degeneracy in the descendant. With the growing tendency of woman to pass from the ill-paid work of the seamstress to the better paid but dangerous occupations, a certain seeming increase in degeneracy must result.

The influence of contagious and infectious diseases upon developmental pathology or suppressive evolution is by no means slight. Any disease that produces grave constitutional defects in the parent is likely to be intensified in the offspring. The greatest social dangers result from tuberculosis; the next from syphilis. Typhoid fever, scarlatina, small-pox, measles, diphtheria, whooping-cough, and all contagions, however, may produce these constitutional defects, either through the pregnant mother or through their secondary effects on the ancestor's constitution. If the subject be attacked before the close of the periods of dental stress, an arrest of development of the bones of the face may result, with irregularities in the shape and position of the teeth. These then are stigmata of degeneracy especially due, in the individual presenting them, to the contagions and infections rather than to inheritance alone.

Two agencies producing profound constitutional alteration in a victim, which predispose to degenerative factors like alcohol and which increase the effect of these are, as Kiernan (Journal of Mental and Nervous Disease, 1881) pointed out nearly a quarter of a century ago, traumatism and isolation. There is a deep-seated

neurosis produced by these, attended by a suspicional state, and accompanied with metabolic changes which result in glycosuria, and which aggravate the coexistent neuroses. The influence of these states on the offspring I have elsewhere (Degeneracy, Its Causes, Signs and Results) pointed out in their relation to the effect of alcohol.

The relations of heredity are far more intricate than is usually assumed to be the case in the average discussion of the subject. The problem consequent on impregnation is not that involved in the mere carrying of the mixture of parents in a fully developed form through intrauterine life. Impregnation moreover depends on the preparation of the ovum for the spermatozoon. The centrosome (a body belonging to the period when the ovum has passed from the parthenogenetic to the primitive hermaphroditic stage) has to disappear ere its quasi-function is assumed by the spermatozoon. Furthermore, when the germinal streak has occurred this must be preserved from duplication tending to make duplications of cells or organisms or other minor manifestations of the conditions resultant in double monsters. As all vertebrate organs pass through the same stages before definitely differentiating, the later types have to gain at the expense of the earlier and hence must receive greater energy from the direct ancestors. The want of this energy is shown in the various defects and departures from type which occur in the different degeneracies and congenital defects. For this reason the descendants of a victim of morbidity or abnormality do not always exhibit the disorders or not to the same degree. Sometimes the superior strength of the maternal ancestor and her consequent power of nourishment carry the fetus through the period of defect shown by the father and consequently correct that defect. The types of heredity ordinarily considered are direct heredity where the individual takes after immediate ancestry, and type heredity where he takes after the type to which he belongs. Concerned in this latter is atavism or reversional heredity, where the individual throws back to immediate remote ancestors. This element of atavism tends, through preserving the type, to offset the defects of immediate heredity and, indeed, often underlies the apparent differences between children of the same parents. It likewise prevents equal inheritance from both parents, and sometimes favors inheritance of strength or defect from either. It underlies also so-called

collateral or indirect heredity and the transmutation of heredity. While acquired defects and benefits may be, as even Weismann (Germ Plasm, page 431, 565) admits, inherited this can occur but rarely, since it not only implies weakness of atavism or type heredity, but likewise weakness of maternal constitution and environment during pregnancy and lactation. Much of the alleged inheritance of paternal defects is due to the environment of the mother produced by this defect, as I have elsewhere (Degeneracy, Its Signs, Causes and Results) pointed out in the discussion of the influence of paternal alcoholism. What is true of alcoholism is of course true of all other degenerative factors. The neurasthenic influence of these on the maternal organism during pregnancy and lactation would through simple arrest of maternal functions create defective offspring even were there no direct inheritance of defect.

Manifestations of morbid heredity may not be inheritance of the whole effect but disturbance of relations of structure and hence of function, producing a constitutional deficiency which takes the line of least resistance. The extent and direction of this line of least resistance depends upon the amount of healthy atavism which separate organs and structures of the body preserve. What is true of the organism as a whole is true of the cells forming its organs. While cell life is altruistic or subordinated to the life of the organ and through it to the life of the organism as a whole, still this altruism is not so complete as to prevent entirely a struggle for existence (Roux, Der Kamp der Theile im Organismus) on the part of the cells or the individual organs. With advance in evolution this struggle decreases to increase with the opposite procedure of degeneracy. From it result the phenomena of arrested and excessive development. This struggle for existence was very early pointed out by Aristotle (Osborn, From the Greeks to Darwin), who showed that one organ was often sacrificed for the development of another. This was more clearly pointed out and freed from obscurity by Goethe in 1807 and St. Hilaire in 1818. The law under which this struggle operates is known as the law of economy of growth. Its action sometimes aids, and sometimes, when regular, prevents degeneracy. The vertebrate embryo of the higher type has in it all the potentialities for the organs and structures found in lower types. As ancestry is strengthened these potentialities remain latent. In proportion as the ancestry becomes subject to nervous

exhaustion these potentialities gain nutrition at the expense of the later acquired organs which are the ones likely to be affected by nervous exhaustion. All the organs of the body have practically their own nervous system, which exercises a control over their nutrition through its control over the blood supply and the means of excretion. The excessive action of this local nervous system is regulated by the central nervous system for the benefit of the organism as a whole. Should the central nervous system become weakened the local nervous system is given free play, and first draws greater nourishment and increased power at the expense of other organs. As a result of this increased power the local nervous system becomes itself exhausted and a struggle for existence occurs between its parts. In consequence, as in the case of tumors and cancers, cells take on the power of reproduction which for a long time they had lost for the benefit of the organization as a whole (Degeneracy, Its Signs, Causes and Results). This struggle for existence produces effects which are handed down by heredity or are fought by atavism. These two factors in heredity may play beneficial as well as injurious parts on the offspring. As a rule atavism plays a beneficial part in correcting degenerate tendencies. This part may either be complete in the shape of a perfect return to a normal ancestor or may be so incomplete as to moderate in the offspring the effect of an extended nervous exhaustion of an immediate ancestor.

Consanguineous and neurotic marriages are fruitful sources of degenerate children. Accentuation of family characteristics must always happen from consanguineous marriages, for if there be taint in the family each member will have inherited more or less of it from the common ancestor. Cousins who are descendants of a common grandparent who was insane and of an insane stock inherit more or less of the insane diathesis. Even if the taint has been largely diluted in their case by the wise or fortunate marriages of blood-related parents, they have still inherited a neurotic tendency. If they marry they must not be surprised if that taint appears in aggravated form in their children. Children of such parents may be idiotic, epileptic, dumb, or lymphatic, and the parents marvel whence came the imperfection. In some cases the parents and possibly the grandparents of the unfortunate children have not displayed any obvious evidence of the tendency to disease which they have inherited and handed on to their descendants. Not looking

farther back, the parents boldly assert that such a thing as insanity, epilepsy, scrofula, etc., is unknown in their family. They themselves have never been insane, why should their children be? In like manner children may be epileptic, blind, deaf-mute, lymphatic, cancerous, criminal, drunkards or deformed from direct inheritance and yet the family line be honestly declared healthy. The truth of Sir William Aitken's maxim that "a family history including less than three generations is useless and may even be misleading" is hence obvious. Similarity of temperament induced by a common environment, which Strahan calls "social consanguinity," is also a potent factor in degeneration. Living under similar customs, habits and surroundings, laboring at the same occupations, and indulging in the same dissipation, tend to engender like diseases and degenerations irrespective of blood relationship. Persons not even distantly related by blood are in reality much more nearly related in temperament than cousins or even nearer blood relations who have experienced widely different modes of life. This "social consanguinity" is the great curse which dogs every exclusive tribe and class and hurries them to extinction. It has largely added to real or family consanguinity in the production of the disease and degeneration which have fallen so heavily upon the aristocracies and royal families of Europe. This "social consanguinity" appears likewise in the tendency of the neurotic to intermarry, popularly expressed in the proverb that "like clings to like." This marital likeness in mental characteristics has been shown to be present by Roller, de Monteyel, Kiernan, Bannister and Manning so far as Germany, France, the United States and Australia are concerned.

School-strain evinces itself in a systemic nervous exhaustion manifested along lines of least resistance. The first types of neuroses are due to overstrain of certain territories related with memory as contrasted with diminished use of the association fibers connecting these. In degenerate children, because of deficiencies of proper interassociation of the memory territories in the brain, healthy curiosity and the instinct of sheltering are deficient, so that states of uncertainty, producing terror, result. These become permanent in after life, even when training as adults is strongly antagonistic to them. Overpressure in school in certain respects checks, even in well-developed minds, the transition from the terror of the unknown of childhood into the calm of maturity. Morbid fears, imperative

conceptions, and imperative acts which torture the individual during an otherwise healthy career unquestionably originate in the early periods of life.

Degenerate children, as Kiernan remarks, early manifest decided neurotic excitability and tend to neuroses at physiologic crises like the first and second dentition and the onset and close of puberty. Slight physical or mental perturbation is followed by sleeplessness, delirium, hallucinations, etc.; hyperesthesia and excessive reaction to pleasant or offensive impressions exist; vasomotor instability is present, and pallor, blushing, palpitations or precordial anxiety result from trivial moral or physical excitants. There is no precocity or aberration of the sexual instinct. The disposition is irritable. Psychic pain arises from the most trivial cause and finds expression in emotional outbursts. Sympathies and antipathies are equally intense. The mental life swings between the periods of exaltation and depression, alternating with brief epochs of healthy indifference. Egotism is supreme and morality absent or perverted, and the latter condition is often concealed under the guise of moral superiority, religiosity or cant. Vanity and jealous suspiciousness are common, and the intellect and temper are exceedingly irregular. Monotonously feeble, scanty ideation passes readily into seeming brilliance, even to the extent of hallucinations, but ideas are barren as a rule, because generated so rapidly as to destroy each other ere they pass into action. Energy fails ere aught can be completed. The inability to distinguish between desires and facts produces seeming mendacity. The will in its apparent exuberance, its capricious energy and innate futility, matches and distorts the one-sided talent or whimsical genius which may exist. The whole of this mental state may not be present. The tendency to introspection, to morbid fear, to gloom, to hallucinations, to alternations of depression and exaltation, may occur in a degenerate child in whom has been otherwise preserved that secondary ego which is the latest and greatest acquirement of the race.

Among the signs of fatigue in children is the slight amount of force expended in movement, often with asymmetry of balance in the body. The fatigued centers may be unequally exhausted; spontaneous finger twitches like those of younger children may be seen, and slight movements may be excited by noises. The head is often held on one side; the arms when extended are not held horizon-

tally, and usually the left is lower. The face is no evidence of bodily nutrition, as it may be well nourished, yet the body be thin. Three per cent of the children seen in school are below par in nutrition, and these children are of lower general constitutional power. They tend to an ill-nourished condition under the stress of life and many cases of mental excitement which, while rendering them sharper mentally, militate against general nutrition.

School strain produces, like all the acquired factors of degeneracy, a systemic nervous exhaustion which may be expressed either in general neuropathy or hysteria after puberty or in the tropho-neuroses, like gout and allied states, or in epilepsy or arterial change, predisposing to rupture of arteries at periods of stress, with resultant convulsions and paralysis.

Nothing does so much to bring about degeneracy as the exhausting social functions undergone by young women just before marriage. Brides become so exhausted that they can hardly stand at the altar. Women in nourishing their children cannot only overcome their own defects but likewise those of their husbands. It is therefore better for a prospective bride to isolate herself and rest rather than undergo the stress of social functions in celebration of her approaching marriage. Few women under existing methods of life can rear a large family destitute of mental and physical defect. The same was equally true of past centuries, whence the congenitally defective ancestors of the present generation.

Neurasthenia in the parents from all the conditions herein enumerated affects pathologically the development of the child. This implies a practical degeneration in function, since tone is lost.

Every nerve cell has two functions, one connected with sensation or motion and the other with growth. If the cell be tired by excessive work along the line of sensation or motion the function as regards growth becomes later impaired, and it not only ceases to continue in strength but becomes self-poisoned. Each of the organs (heart, liver, kidneys, etc.) has its own system of nerves (the sympathetic ganglia) which, while under control by the spinal cord and brain, acts independently. If these nerves become tired the organ fails to perform its function, the general system becomes both poisoned and ill-fed, and nervous exhaustion results. In most cases, however, the brain and spinal cord are first exhausted. The

nerves of the organ are then allowed too free play and exhaust themselves later. This systemic exhaustion has local expression in the testicles in the male, in the womb and ovaries in the female. Because of this condition the body is imperfectly supplied with the natural antitoxins formed by the structures; the general nervous exhaustion becomes more complete, and all the organs of the body are weakened in their functions. Practically the neurasthenic in regard to his organs has taken on a degenerative function, although not degenerating in structure, since the restlessness of the organs is a return to the undue expenditure of force which occurs in the lower animals in proportion as it is unchecked by a central nervous system. Through the influence of various exhausting agencies the spinal cord and brain lose the gains of evolution and the neurasthenic is no longer adjusted to environment. Since the reproductive organs suffer particularly, children born after the acquirement of nervous exhaustion, more or less checked in development as the influence of atavism is healthy or not, repeat degenerations in the structure of their organs, which in the parent were represented by neurasthenic disorders in function. As the ovaries of neurasthenic women generally exhibit prominently the effects of the nervous exhaustion, the disappearance of the centrosome is not properly effected and sufficient stimulus by the spermatozoon is not secured, and the offspring of these do not gain enough vigor to pass through the normal process of development.

THE STIGMATA OF DEGENERACY.

By EUGENE S. TALBOT, M.D., D.D.S.,
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Perhaps there is no subject at the present time that is of so much importance as that of human degeneracy. It is of interest to the physician from its relation to inherited tendencies, to diseases like tuberculosis, cancer, insanity and bodily defects; to the dentist, in connection with

Fig. 1.

deformities of the jaws and irregularities of the teeth; to the jurist, in connection with civic and criminal litigation; to the teacher, because of the mental and nervous instability of pupils; to the minister and philanthropist, because of its relation to vice and pauperism; to the community at large, because reproduction of defectives results in parasites which disgrace society and fill public and private institutions with defective dependents.

Moreal of France, fifty years ago, laid down the essential principles governing human degeneracy. Since his time, although many scientists

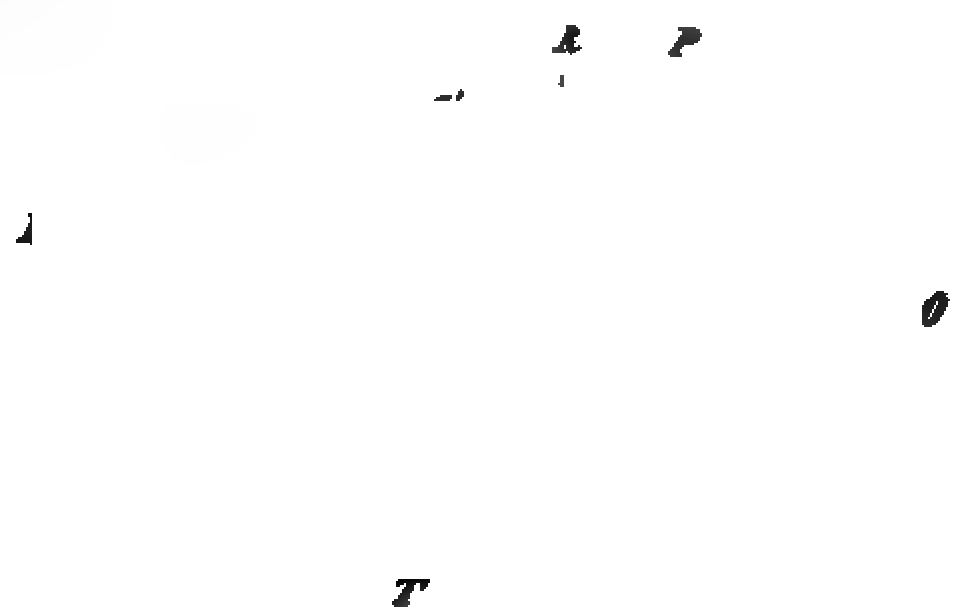


Fig. 2.

have labored with the subject, none have forced it so much to the front as Lombroso, of Turin, Italy. Lombroso, however, made the fatal error of trying to establish a peculiarly criminal type. His pupil, Max Nordau, by his "Degeneration" popularized Lombroso's views. As Lombroso

remarked, "Nordau with a stroke of the pen has accomplished at once what I have been trying to do in the past thirty-seven years."

Nordau's work excited the literati more than the scientist, since he attempted to diagnose degeneracy of authors from literary productions.

Fig 3. Fig. 4.

The scientific methods of study of the degenerate are based on the status of physical development, which produces deformities of the brain and body called, "Stigmata of Degeneracy."

Degenerates of the marked type are, therefore, the congenital deaf, dumb, blind, insane, idiots, criminals, paupers, harlots, extreme egotists, one-sided genius, kleptomaniacs, habitual liars, "smart" business men and "eccentric" people. These all display stigmata to a marked degree.

These stigmata are evinced in excessive or arrested development of tissue or the entire individual. The degenerate, therefore, should be studied from the standpoint of his stigmata.

Figure 1[1] illustrates a fetal brain at six months. No convolutions have yet developed, though the fissure of Sylvius is well marked. The surface of the brain is smooth. Figure 2 is a normal adult brain of the mathematician Gauss. Marked change is noticeable in the development of a large number of convolutions scattered over the surface. The larger

Fig. 5. Fig. 6.

the number and the deeper the convolution, the greater the distribution of gray matter. Figure 3 shows the side view of the brain cut into near the median line. The depth of the sulci is marked, especially in the anterior part. The fine subdivision of the convolutions affords space for much

[1]The illustrations were obtained from Prof. D. R. Brower's collection and medical and dental works.

gray matter. Figure 4. The location and white matter affords expression to the intelligence. From these extremes it is easy to understand how from any cause the brain may cease development at any period between the two. Such cessation has occurred in the brain of an idiot (Figure 5),

Ha.R.

Fig. 7.

where the brain is very small, the anterior and posterior parts are wanting and the convolutions are very large and also in that of an imbecile (Figure 6), where the convolutions are very large and scattered, but the anterior development is deficient. A more marked deficiency appears in the brain of an idiot (Figure 7), in which the cortical of the left hemisphere is

Fig. 8.

entirely wanting. In this case, as in most cases of porencephaly an attempt has been made to compensate this loss of development of many small convolutions. Each of these layers performs some particular function. Figure 8 is a side view of the brain of a man, showing the location

of some of the various functions. Thus (1) is the center for the movement of the opposite leg and foot; 2, 3, 4, centers of complex movements; 5, extension of forearm, etc.; 13, vision; 14, hearing. If these centers should be destroyed or should not develop, these functions could not be performed. A section from one of these areas prepared and placed under the microscope shows layers of cells.

Aside from bulk development and development of convolutions, cell

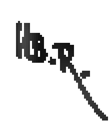


Fig. 9.

or neuron development is the most important factor. Thus a New York imbecile's brain weighed four ounces more than that of Cuvier. On the other hand, people with small brain growth like Gambetta and Shelley may frequently be very bright and intelligent. Brain cells possess three functions, sensation, coördination and growth.

At birth, the brain is the largest part of the body. It weighs one-fifth of the entire body, while in the adult it is but one-thirty-third.

During the first six months it doubles in weight. Hence stability of brain evolution is necessary to normal development of the body.

Degeneracy, according to Ray Lankester,[2] is a gradual change of structures by which the organism becomes adapted to less varied and

Fig. 10.

complex conditions of life. The opposite progressive process of elaboration is a gradual change of structure by which the organism becomes adapted to more varied and complex conditions of existence. In elaboration there is a new expression of form corresponding to new perfection of work in the animal machine. In degeneracy there is suppression of form corresponding to the cessation of work. Elaboration of some one organ

Fig. 11.

may be a necessary accompaniment of degeneracy in all others. This is very generally the case. Only when the total result of the elaboration of some organs and the degeneracy of others is such as to leave the whole mass in a lower condition, that is, fitted to less complex action and reaction

[2]Degeneration.

in regard to its surroundings than is the type, can the individual be regarded as an instance of degeneracy.

As Harriet Alexander[3] has shown, since degeneracy is a process of evolution, leading to alteration of form because of cessation of inhibition

Fig 13.

in certain directions resultant on diminished work, it logically follows that since diminished function precedes change of structure, increased function must check the change of structure in its biochemic stage. Nay, more, it is evident that structural elaboration due to degeneracy may be retained while the degenerate structures resume their higher functions. Hence a degenerate race may rank higher in evolution because of the

Fig. 14.

utilization of the beneficial variations due to degeneracy. The influence of this principle is increased by the fact that the majority of the children of degenerates inherit a tendency to degeneracy rather than degeneracy itself.

[3]Medicine, 1896.

Since as Kiernan[4] points out, certain parts may disappear in the evolution of the organisms, and since the disappearance and developing tendency must center around the type when certain functions will be lost by the disappearing and others gained by the developing, periods of stress

Fig. 15.

must occur, around which the law of economy of growth will center the struggle for existence between the parts of organs and between the organs. Struggles for existence on the part of the different organs and systems of the body are hence most ardent during the periods of intra and extra-uterine evolution and involution at the four and one-half months' period of fetal life. During the first dentition, during the second dentition (often

Fig. 16.

Fig. 17.

as late as the thirteenth year), during puberty and adolescence (fourteen to twenty-five), during the climacteric (forty to sixty), when uterine involution occurs in woman and prostatic involution in man, and finally

[4]Medicine, 1901.

during senility (sixty and upwards), mental or physical defect may, as I have elsewhere shown,[5] occur; a congenital tendency to which has remained latent until the period of stress.

There is an important stress period at four and one-half months' intra-uterine life, called the simian or senile period (Figure 9). This wrinkled, dried up appearance which is sometimes noticed at birth and which remains throughout life is due to native inferiorities of constitution, of temperament, of vital resistance, perchance to retardation, arrests or imperfections of development, mental, physical or manifested in organic changes which produce either malformation of organs or monstrosities. Arrests and excessive developments which so frequently begin at this period are often spoken of as inherited peculiarities. Such a theory does not account for a monstrosity or arrested development where the parents have been normal for three or four generations. Arrest markedly noticeable in even seemingly normal man of certain races occurs from the third

F'g. 12. Fig 18.

year onward when further growth, though an absolutely necessary adaptation to environment, is to some extent growth in degeneration and senility.

The body, and especially the head, retains its childlike appearance throughout life (Figure 10) due to arrest of the bones in the face, and not in the bulk of brain, but in cell development. This is why some men and women retain the fresh, youthful appearance late in life. In many cases such people are superficial in mental development. This type is frequently found among harlots.

The eruptive fevers or other constitutional disease will produce arrests of development in every child, some times for a short period and again for life. Figure 11 illustrates a person thirty years of age whose development became arrested at eight. He possesses the brain of a child at that age. Any structure of the body is liable to become arrested or excessively developed as a result of constitutional disease producing an

[5] Degeneracy.

unstable brain. Children recovering from the eruptive fevers or other constitutional disease should be given a change of climate, food and environment when practicable

While it is possible only in a general way to draw conclusions of brain stigmata by the shape and contour of the skull, yet there are many stigmata in connection with the head which are of value in determining human degeneracy. Many of these are markedly visible in the head and skull of the criminal Gasparone, Figure 12. The head is dolichocephalic with exceedingly low forehead and excessively developed occipital region. The excessively developed orbital cavities and super-orbital ridges with sunken eyes are atavistic, since they are Neanderthaloid. The excessively developed visual region of the brain, together with the stigmata previously mentioned, indicate atavism along the line of primitive man in warfare.

Fig. 19.

The excessively developed jaws, malar bones, mastoid processes and occipital ridges are also atavistic, since they indicate the attachment of heavy powerful muscles for biting or mastication. The inca or wormian bones due to imperfect development of the dermal bones of the skull are a marked sign of degeneracy.

The physician should know what the average normal type of head and face of a given race is before drawing conclusions. Thus brachycephaly may be normal in the German races. High cheek bones are normal in the Mongols and American Indians, etc. Excessive protrusion of the jaws is normal in negroes. In studying the degenerate faces, two imaginary lines are drawn, one at the median line of the head and face dividing them into two halves, the other by extending a perpendicular line from above, and touching the super-orbital ridge to below the chin. By starting from these lines, unilateral development of the face can easily be studied as well as protrusion or recession of the forehead, face and jaws.

Among striking features of the degenerate head are arrest of development of the frontal region, the excessive or arrested development of the bregma, and the excessive or arrested development of the occipital region. Usually one side of the head is excessively developed,

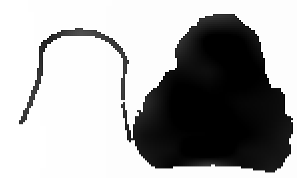
Fig. 20.

the other is arrested. One ear is higher than the other, the supra-orbital ridges excessively developed, the orbital cavities are large, the eyes small, sunken, set close together or very far apart, the cheek bones excessively developed or one larger and higher than the other, the face arrested or

Fig. 21.

excessively developed, usually arrested, the lower jaw excessively developed or arrested. These points are indicated by the two imaginary lines.

Figure 13 shows a criminal colored boy from the New York State Reformatory. The most marked stigmata here displayed are sphenocephaly (wedge-shaped head) arrested jaws, excessively large right orbit and arrested ears. This brain is macrocephalic as a result of arrested hydrocephalus. It is markedly degenerate either in the white or negro. A line dropped from the super-orbital ridge shows that the head, face and jaws were developed upon that line. In Caucasic races this would be consid-



Figs. 12 and 13.

ered a normal face, but in a negro of so low a type, the jaws should protrude far below this line; they are hence arrested.

Figure 14 shows two types of degenerate faces. A line dropped from above the supra-orbital ridge shows the forehead to be low and very narrow, with lack of frontal brain development. The lower jaw, which seems to be excessively developed, is normal. The face, from the supra-orbital ridge down to and including the superior teeth, is arrested; the face has a hollowed out appearance.

Dropping a line in the same manner from the supra-orbital ridge

Fig. 14.

would show the same forehead as in the other, but just the opposite condition of the face. The face is excessively developed; the lower jaw arrested. There is, however, marked lateral arrest of development of the face and lower jaw (which does not appear in a side view picture), producing a hatchet face.

By applying these rules to degenerates of different races, taking into consideration race types, it is obvious that there is very little difference in stigmata except in degree. The higher the race in the order of evolution, the more intensified the deformity. Figure 15 illustrates English criminals. The head and face stigmata are very marked. Figure 16 shows Italian criminals. The forehead is arrested, the small sunken eyes set close together and wide apart, there is lateral asymmetry. Figure 17 illustrates Russian harlots with exceedingly low foreheads, small sunken eyes and facial arrest.

A degenerate type often found in America is that of Patrick Eugene Joseph Prendergast, Figure 18, the assassin of Carter Harrison. Height, five feet, seven inches; weight, 132 pounds; hair, red, coarse and stiff; very little upon face. Nose, fairly normal, thin at bridge, broad at alæ. Ears, large and projecting, lobes, short and broad, tragus well developed; helix broad, with typical tubercles at the upper and outer border of the ear. Lips, upper, small and thin; lower, excessively developed, more

Fig. 25 and Fig 26.

prominent because of undeveloped upper jaw. Arrest of development of the bones of the face, especially at the alæ of the nose. Zygomatic arches normal, but appear prominent owing to the arrest of the bones of the face. Lower jaw normal. Forehead receding. Head sunken at the bregma; occipital region excessively developed, circumference, 22.2 inches (57 millimeters) anteroposterior 7.75 inches (20 millimeters) lateral 6.36 inches (16½ millimeters); lateral index 82; therefore extreme brachycephalic. Feet, large; hands, normal; fingers, long and skinny. Width outside first permanent molar, 2.25 inches; width outside second bicuspid, 2 inches; width of vault, 1.25; height of vault, .75; anteroposterior, 2.

Of typical faces of the degenerates; the following are here illustrated: Figure 19 is a photograph of Charles V, of Germany, in his coffin, taken nearly 300 years after death. The face is markedly deformed. The forehead is broad and low. The eyes wide apart. The left eye higher than the right. The nose long and slender. The cheek bones, bones of the face and upper jaw are arrested in development. The lower jaw protruded from three-fourths to one inch beyond the upper. The mouth is open from excessive development of the ascending rami. He was a mouth breather. This man, although an enormous eater, could not chew his food properly. The upper jaw was so small that the teeth closed inside of the lower. A large number of special cooks were required to prepare his food, so that it could be swallowed. Figure 20 is that of Judas. Had the artist lived at the present time and been familiar with the degenerate type, he could not have portrayed a better likeness than is here displayed. The head and face of the degenerate nobility type; the

Fig. 27.

small eyes, arrest of the face and upper jaw, and the excessive lower jaw stamp him as a very degenerate person.

The sense organs most apt to show defect are the ears. The reason is that they are cartilaginous organs springing from the side of the head and attached to bony bases. The blood supply is scanty and irregularly distributed. In an examination of 6,000 ears of persons ranging in age from twelve to fifty years, it was found that the average length is 2.50 inches; width, 1.25 inches. Ears of these dimensions, all parts being developed in proportion, should be considered normal. Each ear develops from six little buds forming a part of the normal ear. If, on account of an unstable brain, these buds do not develop harmoniously, an abnormal ear results. Figure 21 shows a number of deformed ears of criminals. None of these are graceful in outline. Some are more arrested than others. Unlike any other organ of the body, the ear grows throughout

life, thus old people are frequently seen with large and long ears. This is especially true of defective people. The color of the ear is a sign of the physical condition of the child. When white, it indicates fatigue.

The structures which are next most easily affected by degeneracy are the jaws and teeth. These defects are the result of both excessive and arrested development of one jaw, or want of harmony in the development of both. The upper or lower may protrude beyond the imaginary line. The upper may become arrested and a V (Figure 22) or a saddle-shaped (Figure 23) arch be produced.

The law of Aristotle, whereby a structure or organ is lost for the benefit of the organism as a whole, is here beautifully illustrated. Figure 24 illustrates the advance of the brain and the recession of the face and jaws in the order of evolution as shown by the perpendicular line. The brain is still advancing and the jaws are still receding until to-day, in an

Fig. 28.

examination of 10,000 people in London, 83 per cent. possessed jaws inside of the line, and among 3,000 English school children, 93 per cent. had jaws inside of the line. The face and jaws are hence transitory structures, and are the first to be arrested or excessively developed by an unstable nervous system. The V and saddle-shaped arches are the result of arrest of the upper jaw. There is no room for the teeth to develop in a normal manner. Whether the jaw will become V or saddle-shaped depends upon the order of the eruption of the teeth, which is purely mechanical.

Figure 25 illustrates hypertrophy of the alveolar process which is a very common stigma in the degenerate. It has been claimed that the hypertrophy produces a deformed palate, which is not the case. In the cases illustrated, the palate is normal, but because of an unstable nervous

system and of the transitory nature of the alveolar process, it becomes enlarged, sometimes extending across the mouth, meeting at the median line.

Man at his present stage of evolution has twenty teeth in his temporary and thirty-two in his permanent set. Any deviation in number is the result of embryonic change occurring between the sixth and fifteenth week for the temporary teeth, and the fifteenth week and birth for the permanent. The germs of teeth which erupt late in life and are (properly) called third sets, appear ere birth and are completely formed at the beginning of the second year, although they remain protected in the jaw until late in life. This is an expresson of polyphyodont atavism.

More than twenty teeth in the temporary set or thirty-two in the permanent set is an expression of atavism.

From a maxillary and dental standpoint, man reached his highest development when well developed jaws held twenty temporary and thirty-two permanent teeth. Decrease in the numbers meant, from the dental standpoint, degeneracy, albeit, it might mark advance in the man's evolution as a complete being. *Marsh points out that in the New Mexican lower eocene occur a few representatives of the lowest primates, such as the lemurarius and limnotherium, each the type of a distinct family. The lemurarius, closely allied to the lemurs, is the most generalized primate yet to be found. It had forty-four teeth in continuous series above and below. The limnotherium, while related to the lemurs, had some affinities with the American marmosets. †A. H. Thompson in discussing the "missing teeth" of man, remarks that these researches suggested and subsequent studies aided solution of the problem of the origin of the extra teeth (known as supernumeraries) which sometimes occur in man. These, usually regarded as pure freaks, like polydactylism are, however, excellent illustrations of atavism demonstrating that man during his evolution from the lowest primate has lost twelve teeth. These supernumerary teeth assume two forms—either they resemble the adjoining teeth or are cone-shaped. Figure 26.

While supernumerary teeth may be located at any point in the mouth, as noticed in one of the illustrations, they are usually found in either the extreme posterior, like the middle figure, or the extreme anterior, as seen in the smaller figure.

Stigmata of degeneracy are not confined to the upper part of the body. All structures may be involved, as is often shown by the arrest of the right forearm and the excessive development of the middle finger of the left hand. Figure 27. Next to the ears and jaws the vermiform appendix is probably most liable to degeneracy. This organ varies in length and location alike.

Figure 28 illustrates the evolution of the foot from the perfectly flat foot of the negro to the high arched foot. Degenerates usually possess a nearly or quite flat foot. They often have the prehensile power of the foot found in the anthropoids.

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*Vertebrae Life (Proceedings American Association for Advancement of Science, 1877.)

†Dental Cosmos, 1894.

DEGENERACY AND POLITICAL ASSASSINATION.

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In dealing with political assassination as with other phases of sociology, racial and national tests alone are applicable. On the continent of Europe assassination has always played a part in politics. Even during the nineteenth century the axiom of Dumas[1] that in politics "we do not kill a man, we remove an obstacle," was acted on by royalist, imperialist, nihilist, and churchman alike. The English, as Macaulay[2] points out, regard "assassination, and have during some ages regarded it, with a loathing peculiar to themselves. So English, indeed, is this sentiment that it cannot even now be called Irish, and that till a recent period it was not Scotch. In Ireland to this day the villain who shoots at his enemy from behind a hedge is too often protected from justice by public sympathy.

"In Scotland plans of assassination were often during the sixteenth and seventeenth centuries successfully executed though known to great numbers of persons. The murders of Beaton, of Rizzio, of Darnley, of Murray, of Sharpe, are conspicuous instances. The royalists who murdered Lisle in Switzerland and Ascham at Madrid were Irishmen; the royalists who murdered Dorislaus at the Hague were Scotchmen. In England, as soon as such a design ceases to be a secret hidden in the recesses of one gloomy, cankered heart, the risk of detection and failure becomes extreme. Felton and Bellingham reposed trust in no human being, and they were therefore able to accomplish their evil purposes. But Babington's conspiracy against Elizabeth, Fawkes's conspiracy against James, Gerard's conspiracy against Cromwell, the Rye house conspiracy, Despard's conspiracy, the Cato Street conspiracy, were all discovered, frustrated, and punished. In truth such a conspiracy is, in England, exposed to equal danger from the good and from the bad qualities of the conspirators. Scarcely any Englishman, not utterly destitute of conscience and honor, will engage in a plot for slaying an unsuspecting fellow creature, and a wretch who has neither conscience nor honor is likely to think much on the danger which he incurs by being true to his associates and on the rewards which he may obtain by betraying them. There are, it is true, persons in

[1] Count of Monte Cristo.

[2] History of England, vol. v, p. 120.

whom religious or political fanaticism has destroyed all moral sensibility on one particular point, and yet has left that sensibility generally umimpaired. Such a person was Digby. He had no scruple about blowing King, Lords, and Commons into the air, yet to his accomplices he was religiously and chivalrously faithful; nor could even the fear of the rack extort from him one word to their prejudice. This union of depravity and heroism is rare. The majority of men are either not vicious enough or not virtuous enough to be loyal and devoted members of a treacherous and cruel confederacy, and if a single member should want either the necessary vice or the necessary virtue, the whole are in danger. To bring together in one body forty Englishmen all hardened cutthroats and yet all so upright and generous that neither the hope of opulence nor the dread of the gallows can tempt any one of them to be false to the rest, has hitherto been found, and will, it is to be hoped, always be found, impossible."

Another Gerard conspiracy in addition to that referred to by Macaulay was directed against William the Silent. Gerard (Fig. 1), born in 1558, killed William the Silent July 10, 1584, and was executed July 14. In the conspiracy were Dutch, English, French, Italian, and Spanish ultramontanes. The deed was favored by the Jesuit faction and met with approval by high ecclesiastic dignitaries. Gerard was almost canonized by the Spanish monarchists. For some years he had displayed egotistic evidences of paranoia, and had labored at the conspiracy for six years. Through paranoiac anesthesia he endured torture so courageously that Dutch, English, French, and German protestants believed that the devil aided him. He had a kephalonic scaphocephalic cranium. The eyes were small, sunken, and unequally placed; the bones of the face and nose were arrested in development, as also was the upper jaw.

FIG. 1—Gerard.

This prejudice against assassination as a political weapon, while common in the Northern United States, is not found in the Southern. The attack on Sumner by Brooks in the halls of Congress, although of the nature of political assassination, met with approval in the South. The recent assassination of Goebel by Kentucky republicans does not seem to have aroused special horror in the South. The feeling among the opposing party in Kentucky is vengeance rather than loathing.

While factors of this kind discount the value of assassination as an absolute test of mental disorder or degeneracy, still it cannot be controverted that most assassins are abnormal. The reason for this has been pointed out by Macaulay in his discussion of the case of Grandval, who was "undoubtedly brave and full of zeal for his country and Roman Catholicism. He was, indeed, flighty and half-witted, but not on that account the less dangerous. Indeed, a flighty and half-witted man is the very instrument generally preferred by cunning politicians when very hazardous work is to be done." Mock deference, as J. G. Kiernan[1] has pointed out, renders this class of beings the unflinching slaves of party leaders. It is not surprising, therefore, that stigmata of degeneracy are, as I pointed out seven years ago,[2] as frequent among political assassins, who represent the proletariat, bourgeois, and aristocracy, as among royalty.

Assassination in Italy, France, Holland, and Germany during the fourteenth, fifteenth, sixteenth, seventeenth, and eighteenth centuries was a trade carried on for hire. Even in the nineteenth century the Italian bravo and the French paid assassin were not unknown.

In Poland before the extinction of the republic (under monarchic forms) revolutions and assassinations were necessary incidents of government. To this day they are parts of Polish protests against Russian rule. Even as late as 1867 the Pole Berezowski attempted to assassinate Alexander II. at the Paris exposition. These deeds are eulogized in the histories taught in Polish Catholic schools anent Poland.

In Ireland, the prejudice against assassinations for Irish political reasons is non-existent in the south. The *Irish World*, which rabidly denounced the assassination of McKinley, defended the Phœnix Park assassinations committed on innocent persons in order to break off negotiations between Parnell and Gladstone to benefit Irish-American and Irish politicians profiting by funds raised in America for revolutionary purposes. This last procedure has been much employed in Europe and Ireland for the purpose of leading the government to measures so extreme as to force moderate men into revolution. A useless, blatant adherent is often killed by his own party to cast blame on the opposite party. This style of assassination has been so frequently employed in Irish politics that it forms the motif of Carleton's romance, "Crohore of the Billhook."

[1] *Journal of Mental Science*, 1887, p. 193.
[2] *Journal of the American Medical Association*, Nov. 10, 1894.

Assassination may be part of a religious cult. This was the case with the thugs, who were devotees of Bowanee, the destructive female principal of the Hindoo Pantheon.

Acting on Italian principles of government (summarized by Machiavelli[1]) Catherine de Medici converted assassination as she did prostitution into efficient government agencies. Her policy resembled that of Alexander VI. and other Borgias. This Italian policy was adopted against Queen Elizabeth by the ultramontanes. It was also employed by one of the meanest of the mean Stuarts, James I. of England.

While Catherine de Medici employed indifferently any method of assassination which suited her purpose, she was as much of a past master of toxicology as the Borgias. In Italy, indeed, poisoning was so popular as to bear the name of a saint. So late as 1719 poison was sold in Italy under the title of "Manna of St. Nicholas of Barri." St. Nicholas was adopted as a patron saint by criminals. Thieves were popularly known as St. Nicholas's clerks.

The derivation of the word assassin indicates the part drugs played in producing assassins. The "old man of the mountain" administered hashish to his dupes, who were thereby transported to an imaginary paradise filled with houris. To secure this paradise they were ready to obey any errand of the old man of the mountain, and were employed to remove his enemies. Corruption of the term hashish produced the word assassin.

Assassination by a Continental European, by an Irishman, or by a Southerner does not present to the Continental European, the Southerner, or the Irishman the horrid aspect it does to an Englishman or to an American of the Northern United States. Assassination in any of these peoples does not imply necessarily the depth of moral turpitude it does in an Englishman or an American from the Northern United States. Assassination, not necessarily antisocial in character, has been often held noticeably the reverse, as in the cases of Brutus and Tell; hence it is perfectly consonant with even high ethical ideals in other respects.

The policy of Catherine de Medici necessarily created assassination tendencies in parties. The massacre of St. Bartholomew had been preceded by Huguenot attempts at assassinating the Duke of Guise. The mental atmosphere created by the massacre of St. Bartholomew predisposed both Catholics and Reformers to remedy fancied evils by assassination.

Many of the assassins employed were soldiers of fortune, familiar

[1] The Prince.

features of the time, and hence not out of accord with their environment. The two assassins of this period who had the most effect on history were both degenerates. Jacques Clement (Fig. 2), a Jacobin monk, born in the Diocese of Sens, France, in 1567, assassinated Henry III. (the best liked son of Catherine de Medici) August 1, 1589. Clement was an ignorant, excessively bigoted, libertine monk. The mere utterance of the term heretic flung him into fury closely resembling transitory frenzy. He had hallucinations, which judged by the standards of his time were insane. One cited by Regis[1] is as follows: "One night, Jacques Clement being in bed, God sent him an angel, who appeared with a great light showing him a naked sword with these words: 'Brother Jacques, I am a messenger from Almighty God, who comes to announce to thee that by thee the tyrant of France is to be slain; think, therefore, of the martyr's crown prepared for thee.' Thus saying the angel disappeared." Clement had a full, low forehead, the eyes were set far apart, the brow was excessively developed, there was a long, slender nose, the lower jaw was arrested in development.

Fig. 2.—Clement.

Clement's act brought Henry IV. of the Bourbon line to the throne. Henry IV. by entering the Catholic church pacified France and secured for the Huguenots political equality. He was still, however, viewed with horror by the ultramontane party, whose hatred swayed the insane Ravaillac (Fig. 3). He had been a domestic, clerk, schoolmaster, and had received deacon's orders. He had passed the period of adolescence by eight years when he committed the assassination. He was of rather tall stature, powerful and large of limb, cross-eyed, with dark, reddish hair, and was a victim of persecutory delusions and tormented with visual and auditory hallucinations. He entered a Feuillans monastery, but was forced to leave on account of his mental disturbance. He was

Fig. 3.—Ravaillac.

[1] Les Regicides.

altogether unstable. The word "Huguenot" turned his madness into fury. His mind was distracted, bigoted, and susceptible to every morbid religious impression. After he returned from the convent, he was in prison a year for homicide, where he had visions. He had a long, narrow head, with a long, slender nose. The face was asymmetric. There was arrest of development of the bones of the face and upper jaw. The lower jaw was normal. There is no doubt of his mental unsoundness, yet his conduct exhibits vacillation alleged to be inconsistent with insane delusion. Ravaillac's visions and extravagance were the cause of his being expelled from the cloister. At this time, fanatics taught it was lawful to kill those who threatened the Catholic religion. Ravaillac greedily swallowed these principles. He resolved to assassinate Henry IV., whom his overwrought imagination presented in the light of one favorable to heresy. Six months before his crime he set out from Angoulême in order to speak to the king and kill him if he could not convert him to ultramontane views. He did not succeed in obtaining audience, but for some time he was much less disturbed. His visions, however, soon returned and disturbed him. He stole a knife from a Paris tavern and set out on his return home once more. Near Êtampes he broke off the point in a repentant mood, but sharpened it again. He came back to Paris, and dogged the king for several days. At last more determined than ever he slew him May 14, 1610. Ravaillac after being racked was torn to pieces by four horses. He displayed the insensibility to pain common in degenerates.

Clement and Ravaillac effected marked changes in French history which to some extent nullified each other, since the benefits gained by the doctrine of political equality of religions voiced in the Edict of Nantes were nullified by its revocation under Louis XIV., the descendant of Henry IV.

Damien, a paranoiac degenerate who attempted to assassinate Louis XV., had an asymmetric face and his skull was Neanderthaloid in type. The dictum of Macaulay as to the use of flighty and half-witted men by politicians is singularly well illustrated in these three cases. In all the influence of current discontent on the delusions of the insane likewise appears.

The influence of the dislike of the English to assassination is singularly well shown in the fact that attempts made to assassinate the morally imbecile paranoiac George III. were by lunatics. It is a curious coincidence, Ray[1] remarks, that this monarch who suffered

[1] Mental Pathology.

so much from mental disease should have been pursued by insane people. In 1786 Margaret Nicholson, an old woman, attempted to stab him as he was alighting from his carriage; in 1790 John Frith, a lieutenant of the army, threw a stone at him through the window of the carriage in which he was riding; and in 1800 James Hadfield, a soldier, shot at him in a theater. During his illness, in 1788, insane persons often contrived to elude the restrictions of the palace and roam over the grounds. The persons who committed the first two assaults were so obviously insane that the Privy Council sent them directly to Bethlehem Hospital. Hadfield was brought to trial, and on this occasion Erskine made his great forensic effort resultant in acquittal of his client. Hadfield believed he had constant intercourse with God, that the world was coming to an end, and that like Christ he was a sacrifice himself for its salvation. He went to the theater because he would not be guilty of suicide. Though called upon by Heaven he wished that, though a seeming crime, his life might be taken away from him by others. He went to see Truelock (just before the shooting committed as a lunatic), who claimed that the Savior's second advent and the dissolution of things were at hand. This delusion mixed itself with that of Hadfield, who immediately broke out upon the subject of his own prohibition and sacrifice for mankind, although only the day before he had exclaimed that the "Virgin was a whore, Christ was a bastard, that God was a thief, and that he and Truelock were to be enthroned together." He once had the idea of firing over the king's carriage in the street, but believed that he should be immediately killed, which would not secure propitiation for the world. Hadfield had received several cranial injuries: he had a fracture of the second cervical vertebra; through a saber wound a portion of the frontal bone was lost, exposing the membrane. His attempt was simply to secure execution.

FIG. 4.—Ankarstrom.

The coalition of kings against the first French republic, which created the "Terror," was marked by a political assassination. "Swedish Gustav, sworn Knight of the Queen of France, will lead Coalesced Armies," Carlyle remarks, "had not Ankarstrom treacherously shot him, for indeed there were griefs nearer home." Ankarstrom (Fig. 4) was a Swedish gentleman who had become the leader of freedom-loving conspirators against

Gustav. He was born in 1760, and executed in 1792. Gustav was shot at a ball with a pistol concealed in a muff. Despite the suggestively feminine aspect of the stratagem, the muff procedure was a male device. Ankarstrom had a head excessively developed at the occipital region. There was a low, receding forehead. The nose was long, slender, and aquiline. Its bridge was arrested in development, as also was the lower jaw. Among the political consequences of this assassination was the seating of the French stable-boy, Bernadotte, and his descendants on the throne of Sweden.

Among the assassinations which marked the French Revolution were three of note. That there were so few is hardly surprising, considering the ease with which private hatred was satisfied by public denunciation. Among the members of the Republic Convention described by Carlyle[1] is Lepelletier Saint-Fargeau, "Old-Constituent, a kind of noble and of enormous wealth; he too has come hither to have the Pain of Death abolished." Saint-Fargeau voted for the death of Louis XVI. without delay, on a Saturday. At five that evening, Lepelletier Saint-Fargeau ran over to Fevrier's in the Palais Royal to dine. He dined, and was playing, when a thick-set man "with black hair and blue beard," in a loose kind of frock, stepped up to him. Fevrier and the bystanders bethought them of the King's Guards. "Are you Lepelletier?" asked he. "Yes." "You voted in the King's Business?" "I voted Death." "Scoundrel, take that!" cries Paris (Fig. 5), flashing out a saber from under his frock and plunging it deep in Lepelletier's side. Fevrier clutches him, but he breaks off, is gone. Lepelletier lies dead; he has expired in great pain at one in the morning—two hours before that vote of no delay was fully summed up. Guardsman Paris is flying over France; cannot be taken; will be found some month's after, self-shot in a remote inn. This assassination, aided by its avowed advocacy by the Royalists, intensely enhanced the suspicional tendencies of the people, increasing the "Terror." The assassin (39 years of age) had a broad, low forehead, with eyes small and set close together. The nose was

Fig. 5.—Paris.

[1] French Revolution.

excessively developed. There were slender but well developed cheek bones. Both upper and lower jaws were arrested in development. He wrote on the back of his commission as Royal Guard, "My brevet d'hominem, let no one be disturbed. No one was my accomplice in the fortunate death of the scoundrel, Saint-Fargeau. Had he not been at hand I would have done a still better act; I would have freed France of the regicide, the parricide d'Orleans. Let no one worry. All the French are cowards, and I say to them:

> "People, whose crimes dismay everywhere bring,
> With joy and pleasure I quit life's race;
> Since only by death can one flee disgrace,
> Stamped on our foreheads in the blood of our king."

Another assassin who looms up prominently (whose act, like that of Brutus, has received approval from many fierce denouncers of assassination) is Charlotte Corday (Fig. 6). She was of stately Norman figure, in her 25th year, of beautiful, still countenance. She was styled D'Armans while nobility still was. "Barbaroux," Carlyle remarks, "has given her a note to Deputy Duperret — him who once drew his sword in the effervescence. Apparently she will to Paris on some errand." "She was a Republican before the Revolution and never wanted energy." "A completeness, a decision is in this fair, female figure." "By energy she means the spirit that will prompt one to sacrifice himself for his country." "What if she, this fair young Charlotte, emerged," Carlyle remarks, "from her secluded stillness suddenly like a star cruel-lovely with half-angelic, half-demonic splendor, to gleam for a moment and in a moment be extinguished, to be held in memory, so bright, complete was she, through long centuries." On leaving Caen, Normandy, she gave away everything except "Plutarch's Lives," in which she "could converse to the last with (her hero) Brutus." She killed Marat "in order to save the Republic." Marat from a benevolent, philanthropic physician had become a suspicional paranoiac, partly because of congenital tendency, partly because

FIG. 6.—Charlotte Corday.

of oppression, but chiefly, as W. L. Baum[1] has shown, from the onset of diabetes, which attained its height at the time Marat had the most marked suspicions of danger to the Republic. Charlotte Corday refused religious consolation and met death with exultation. She had a low forehead. The skull was platycephalic in contrast with other Norman skulls; it had a greater cranial capacity than usual in women; it was asymmetric and had rare pterygoid wormian bones. There was a rare median occipital fossa. The eyes were short, large, and unequally placed; the orbits were of unequal size; the superciliary ridges were well developed. There was a long, slender nose. The cheek bones were round. There was arrest of the upper jaw and a small undeveloped chin.

The assassination of Marat stimulated the Royalists. Aimee Cecile Renault (Fig. 7), aged 20, formed the design of assassinating Robespierre in 1794, after the failure of Amiral. May 23 Cecile presented herself at Robespierre's residence. Robespierre cannot be seen; she grumbles irreverently. They lay hold of her. She has left a basket in a shop hard by; in the basket are a female change of raiment and two knives. Cecile, examined by Committee, declares she "wanted to see what a tyrant was like." The change of raiment was "for my own use in the place I was surely going to." "What place?" "Prison, and then the guillotine," answered she. Cecile Renault believed she ought to give her life for the return of the king. She was executed with her entire family, who were involved in a Royalist conspiracy.[2] She had an exceedingly developed occipital region with a very low forehead. There was a long, narrow ear. The bones of the nose were arrested in development. The lower jaw was well developed.

FIG. 7.—Cecile Renault.

In the early nineteenth century many attempts at remedying political conditions by assassination were made on the continent of Europe. Carl Ludwig Sand (Fig. 8), born in 1795 and executed in 1820, killed Kotzebue, the dramatist, March 23, 1819. Kotzebue had become a reactionist, but Sand's main object was the idea of becoming a Christ for Germany, thereby securing the deliverance of

[1] Transactions of the Chicago Academy of Medicine, 1900–1.
[2] Carlyle: French Revolution.

humanity. He had a low forehead. His eyes were small and ill-shaped. The nose was well developed and the cheek bones prominent. There was arrest of development of the upper jaw and excessive development of the lower.

FIG. 8.—Sand. FIG. 9.—Louvel.

A similar political assassin was the French saddler Louis Pierre Louvel (Fig. 9). He was born in 1783 and executed in 1820. He assassinated the Duke of Berry in 1820. His plan was to effect a political revolution by killing all the Bourbons, and chose the Duke of Berry as his first victim. He was a paranoiac in whom the stage of transformation has been succeeded by the stage of exaltation. He had a low forehead, with long eyes set far apart and unequally placed, the right being lower than the left. There was arrest of development of the face and upper jaw. The lower jaw was small.

Louis Allibraud (Fig. 10), a clerk, born in 1810, was executed in 1836 for an attempt to kill Louis Philippe. He was a disciple of the extreme Jacobin, St. Just. He attempted to revenge the death of citizens killed in a strike at Lyons, claiming that Louis Philippe had violated his coronation oath as king of the French.

Joseph Fieschi (Fig. 11) had been a member of the secret societies of Italy. He was born in Corsica in 1790, and executed in 1836. Aided by members of an Italian secret society he attempted assassination of Louis Philippe by an infernal machine. The attempt was due to the alleged violation of an oath by Louis Philippe, who had intrigued with the

FIG. 10.—Allibraud.

secret society. There were superciliary ridges over each eye. The head was somewhat kephalonic in type. The eyes were small and unequally placed, the left being lower than the right. The nose was long and slender. The cheek bones were excessively developed. There was arrest of development of the bones of the face and upper jaw. The chin was receding.

FIG. 11.—Fieschi.

Jean Louis Verger (Fig. 12) was born in 1826, and executed in 1857. He was the son of a suicide, and had been deprived of his priestly functions because of the unfounded insane charges made against his *confrères*. He had marked hallucinations of hearing and decided persecutory delusions. He insisted on hearing high mass despite an excommunication. He wrote and spoke violently against the dogma of the Immaculate Conception, then about to be proclaimed by the Pope. While he anathematized his own enemies he avenged outraged religion by killing the Archbishop of Paris in church, with the significant cry, "No goddesses, no goddesses," and regretting, he said, only one thing, that he could not go to Rome to strike another more illustrious victim. He had a rather low forehead. The eyes were small and deep-set. The cheek bones were normal. There were long, handle-shaped ears, and the nose was arrested in development, as was also the upper jaw. The lower jaw was normal.

FIG. 12.—Verger.

A very similar assassination was committed by Cotilla Galeote (Fig. 13), who was almost a replica of Verger in his acts and delusions. He assassinated the Bishop of Madrid in 1886. He was condemned to death, but sent to an insane hospital in consequence of his insane acts after condemnation. He had a full, low forehead. The eyes were small, deep-set, close together. The ears were excessively developed. The nose was long and slender. There was

arrest of development of the bones of the face and upper jaw. There was a deformed palate and a V-shaped arch.

Nicholas Alphonse Aubertin (Fig. 14), a paranoiac inventor, attempted to assassinate Jules Ferry, December, 1887, because of persecutory delusions involving the State and himself. He was sent to the Bicêtre in 1888. He had a well developed head and forehead. The eyes were small and sunken. The nose was normal, and the upper jaw arrested in development.

Fig. 13.—Galeote.

Charles Edward Nobeling (Fig. 15), a Pole, was born in 1848 and died in 1878. He made an assault on William I. of Germany in 1873. The assault was the outcome of an attempt by the Polish party to utilize the nihilist cry for political purposes. The head and forehead were well developed. The eyes were small and sunken. The ears were long and slender. The face was asymmetric. There was arrest of development of the bones of the face and jaw. The nose was well developed.

Fig 14—Aubertin.

Fig. 15.—Nobeling

Jean Passanante (Fig 16), an Italian cook, born in 1849, attempted

to kill King Humbert in 1879. The elder sister had an imbecile son, an albino, a subject of tremor and of extreme asceticism. The elder brother was a paranoiac with systematized religious delusions. Passanante was a great reader of the Bible and an extreme socialist. His crime, like the crime of Bresci, who killed Humbert, was socialistic in origin, prompted by desire to prevent undue taxation for plutocratic contractors. He had a broad, high forehead. The eyes were unequal in size and place; the left was smaller than the right, and the right was lower than the left. The left cheek bone was more prominent and higher than the right. The ears were long and handle-shaped. There was apparent arrest of the lower jaw. Bresci had a lower forehead than Passanante, and his face presented similar asymmetry except that the sides were reversed.

FIG. 16.—Passanante.

Santos (Fig. 17), born in 1872 in Italy, stabbed President Carnot in 1894 in order to avenge the death of anarchists previously executed by the French. Santos was the youngest of six children, and the only one of the family who was not respected, the remainder being hardworking men and women. He left home at the age of eleven, and even then avowed anarchistic principles. His mother was made temporarily insane by her son's crime. The father had epilepsy, said to have been brought on by threats of death by the Austrians while their prisoner in 1848. The necropsy revealed meningoencephalitis over the frontal region. The head was small and the forehead low. The eyes were small, unequally placed, unequal in size, and abnormally shaped. The ears were long, handle-shaped, and pointed. The nose was small at the bridge, broad and flat at the alæ. The face, cheeks, and upper jaw were undeveloped. The lower jaw was seemingly normal.

FIG 17.—Santos.

The Italian who killed Canovas for the torture illegally inflicted on the anarchists imprisoned in Spain was about 25 when executed. He had an asymmetric face with unequally placed eyes, a low forehead, asymmetric cheek bones, and arrest of development of the nose and upper jaw. At the necropsy meningoencephalitis was found.

Luccheni (Fig. 18), the Italian assassin of the Empress of Austria, has an asymmetric face with unequally placed pupils. The left eye is considerably higher than the right, the left ear higher than the right, both being long, jug-handled, and flaring. He has a retreating chin and a flattened occiput. It is an interesting fact that the Empress of Austria ceased her practice of hunting in Ireland because of the threats of the Irish agitators against the hiring of boycotted land. Although the crime of Luccheni has been charged to anarchy, it is much more probable that it was due to the "unredeemed" Italy faction. Luccheni was affiliated at one time with this faction.

FIG. 18.—Luccheni.

The granddaughter of George III., Queen Victoria, who other than in a somewhat higher intellect much resembled him, was attacked by five would-be assassins; all puberty lunatics, who made the attempts for purposes of notoriety. Oxford, for example, had manufactured a delusional secret "society" called "Young England." One of the rules of this "society" was that every member should be provided with a brace of pistols, a sword, rifle, and dagger, the latter two to be kept at the committee-room. A list of members'-factivives' (*sic*) names was given. "Marks of distinction: Council, a large white cockade; president, a black bow; general, three red bows; captain, two red bows; lieutenant, one red bow." There were also found in Oxford's trunk a sword and scabbard and a black crape cap with two red bows. One of the rules required every member to be armed with a brace of loaded pistols and to be provided with a black crape cap to cover his face, with his marks of distinction outside. Three letters in his handwriting were also found in his pocketbook, addressed to himself at three different residences, purporting to be signed by "W. A. Smith, secretary," and to contain statements of what had taken place at the secret meeting of the society. These were all headed "Young England," and dated 16th May, 1839; 14th November, 1839; and 3d April, 1840. In accordance with the English procedure all

the assailants of the Queen were found guilty, but insane, and sent to the criminal insane hospital pending her majesty's pleasure, which practically meant imprisonment for life.

Sipido, who made the attack on Edward VII. when Prince of Wales, seems to have been a puberty lunatic of the type of Oxford. He had been inspired by sympathy with the Boers and not with anarchy.

The first attempt at presidenticide in the United States was made by Lawrence, a paranoiac who claimed the United States as his heritage from the Stuarts. Lawrence in his assault on President Jackson, adopting the slogan of the United States Bank, charged Jackson with an attempt to ruin him through removal of the United States deposits from the bank, which had been created as a joint stock company, of which stock the United States had taken $7,000,000. Jackson's removal of the deposits revealed the disappearance of the bank's capital, inclusive of the stock subscribed by the United States. Lawrence was sent to the insane hospital, where he died.

The next attempt at presidenticide, that of John Wilkes (Fig. 19), the third son of the English tragedian Junius Brutus Booth, was the result of a conspiracy to overthrow the government at the moment of the North's success. The parties concerned (Americans born in the South) intended to kill President Lincoln, Vice-President Johnson, Secretary of State Seward, and the general in command at Washington. The plot was an inventively stupid one, since there was no organized force — only a few guerillas who could have aided the conspirators. With the exception of assassination, the plot was identical with that planned by Mosby earlier in the war, but discovered by Lincoln's police. Booth was 26 years old at the time of

Fig 19—Booth

Lincoln's assassination. As the names of Booth and his father show, the family was affiliated with the extreme branch of the English liberals. The earlier Booths had belonged to the section who were free-thinkers and members of the Calf's Head Club, who dined on a calf's head crowned with parsley on the anniversary of the execution of Charles I. John Wilkes, after whom Lincoln's assassin was named, was an English politician whose outrageous treatment at the behest of George III. had given rise to the rallying cry of "Wilkes and Liberty." Although the political relationships of the elder Booth in themselves were no evidence of the insanity, since they were practically those of the men who founded the United States, still his conduct, despite his histrionic genius, was that of a paranoiac. He was a mystic theosophist. He adopted Buddhist views as to the sacredness of animal life. Like many of the most sanguinary of the French Revolutionists, he was an intense zoophilist. His kindness toward animals was based on the doctrine of transmigration. He was a vegetarian and forbade his family to eat meat. He was well versed in different religions. He gave great importance to the Koran, which he annotated. He read the Talmud in Hebrew, and gravely discussed religious mysteries with Catholic priests. He never failed to bow his head in passing a church. He frequented churches of all denominations, participated with fervor in all their ceremonies, scrupulously observed all practices of devotion, and passed hours in prayer. At the time of Junius Brutus Booth's birth, theosophy was one of the phases of intellectual perturbation due to the French Revolution, and hence was a natural part of his training. John Wilkes Booth, according to J. G. Kiernan,[1] exhibited decided insanity of manner, which created a certain amount of fear among children. Both he and the elder Booth threw themselves into the parts they played to such an extent as to become the character and alter the course of the drama. The elder Booth while playing Richard III. refused in the last act to die, believing he was Richard, and fenced his oponent off the stage through the door into a street. His opponent, becoming exhausted from parrying his deadly thrusts, called upon the people to interfere. The head and forehead of John Wilkes were kephalonoid. The ears, excessively and abnormally developed, inclined strongly to the so-called Satanic type. The eyes were small, sunken, and unequally placed. The nose was normal. The facial bones and upper jaw were arrested in development, and there was a partial V-shaped dental arch. The lower jaw was well developed.

At the time of the intense American excitement over the con-

[1] *Journal of Mental Science*, July, 1887, p. 193.

tested election of Hayes, a religious paranoiac from Illinois, named the "Prophet Meyers,"[1] came to Washington with the intention of planting a bullet in the heart of Hayes when he took the inaugural oath. The night before Meyers encountered a gentleman whom he recognized as "John the Baptist." This gentleman, a member of the United States Secret Service, recognizing Meyers's mental state, led him quietly and gently to the proper quarters for incarceration in the insane hospital. In consequence a deed which would have thrilled the world and might have led to civil war, through the partisan hatred it engendered, was prevented. Meyers had intended this deed as a protest against the injustice done by the Electoral Commission, which "was a stench in the nostrils of the Almighty."

One of the succeeding assassinations was the act of a man of that Huguenot stock which has sacrificed much to its religious convictions. Probably no assassin ever executed went into court with such decided evidence of insanity. Charles J. Guiteau (Fig. 20) shot President Garfield for the openly avowed reason that he was about to wreck the Republican party, and because the conception leading to the homicide was an inspiration of the Deity. From the evidence presented at the trial, the results of the autopsy, and of the microscopic examination, alienists the world over agree as to his insanity and its type. W. W. Ireland[2] is of opinion not only that Guiteau was insane, but that J. G. Kiernan, treating him as a paranoiac (Primäre Verrückte), put him into his right place among the insane. This form of insanity, based either on an acquired or inherited neuro-degenerative taint, manifests itself in anomalies of the conceptional sphere,[3] which while they do not destructively involve the entire mental mechanism,

FIG. 20.—Guiteau.

[1] Godding: *American Psychological Journal*, 1883.
[2] Through the Ivory Gate, p. 213.
[3] E. C. Spitzka: *New York Medical Gazette*, May 15, 1880.

dominate it. There is a permanent undercurrent of perverted mental action peculiar to the individual running like an unbroken thread through his whole mental life; obscure it may be, for these patients are often able to correct and conceal their insane symptoms, but it nevertheless exists and only requires friction to bring it to the surface. Since this psychosis depends in its original type upon brain deformity, not disease, the good or ill health of the patient has no bearing on the question of insanity. This test should not be given the absolute value it has been in the Guiteau and Czolgosz cases. Guiteau's ancestry was defective on both sides. The mother suffered from an acute brain disease prior to and at the time of his birth, and was for years "a nervous invalid." The father was regarded as a lunatic by clergymen, lawyers, alienists, and others with whom he came in contact. A brother of the father died insane in Bloomingdale Insane Hospital. His hospital history shows that there was hereditary insanity in the family for generations prior. The homicide's brother showed strange peculiarities. The sister is a hysteroepileptic, and was once adjudged insane in Illinois.

With such a family history, hereditary stigmata are to be expected, and defective as is the record, these are found. Drs. McLane Hamilton (called by the State), E. C. Spitzka, and J. G. Kiernan (called by the defense) agree that the skull exhibited decided asymmetry. This, as Kiernan remarks,[1] extending to the face, produced what Spitzka called a "lop-sided smile," and also involved the eyes. Spitzka lays great stress on the asymmetry of the convolutions in either hemisphere, especially those of the island of Riel. There were on the right side five fissures and six straight gyri, on the left seven fissures and eight gyri. The right hemisphere was less developed than the left. Spitzka states that aberrations in development of the kind discovered in Guiteau's brain have not[2] been found in others than persons of unsound mind, and the only finding, in the brain of constitutional lunatics of paranoiac tendencies which promise to establish a relation between the insane and the state of the brain, consists in such architectural anomalies. The pathologic lesions found in Guiteau's brain were adhesions of the dura mater to the inner table of the skull along the longitudinal sinus, and adhesions of the dura to the pia mater and to the brain at spots on the vertex. Other pathologic defects were found in the brain. Marked asymmetry was evident in the head and face. The head and forehead were fairly well developed. The eyes were set close together; the right was apparently higher than the left. The ears

[1] *Chicago Medical Review*, Dec. 18, 1881.

[2] *American Journal of Neurology and Psychiatry*, vol. i.

were excessively developed. There was arrest of development of the alæ of the nose; the jaws were normal. Microscopic examination revealed, in the opinion of E. O. Shakespeare, such marked evidence of disease and defect as to warrant the opinion that Guiteau was mentally abnormal.

An attempt on the life of President Cleveland was made in 1885 by Tobey Allen, a colored paranoiac, who had delusions of persecution by witchcraft which had led him to commit grand larceny for the purpose of being sent to the penitentiary as a protection against his persecutors. He made his way into the White House, but was detected before reaching the family apartments. The motive for his visit was the desire to compel Cleveland to enforce the laws against witchcraft.[1]

Speaker Randall was assaulted by Colonel Pinchover, a paranoiac with delusions as to claims against the United States. Randall recovered from the injuries inflicted, and his assailant was sent to the insane hospital. Blaine, when Secretary of State, narrowly escaped death at the hands of a paranoiac named McNamara, whose assault was stimulated by the outcry against Blaine in connection with the Mulligan letters.

Patrick Eugene Joseph Prendergast (Fig. 21) was 25 years of age when he shot and killed Carter Harrison in 1893. There had been, during the campaign which elected Harrison to the mayoralty, much agitation over the question of track elevation to prevent railroad homicides. This was one of the issues on which Harrison had been elected. Prendergast, a poor newspaper carrier, had loudly advocated the issue in his ward and had made himself prominent thereby. He had met Harrison during the campaign and claimed that he had been promised the position of corporation counsel, so that he could expedite the cause of track elevation. He had barely a common-school education and was destitute of even the ordinary business notions of law. He went

FIG. 21.—Prendergast.

1 J. G. Kiernan: *Journal of Nervous and Mental Disease*, 1886.

to the corporation counsel's office, who by way of a jest introduced him as the coming corporation counsel. Six months after Harrison's election he shot and killed him, on the ground of his nonfulfilment of his promise in regard to track elevation and his failure to appoint Prendergast corporation counsel. The trial of Prendergast was a formal one. Nearly every leading alienist of Chicago testified that Prendergast was a paranoiac, or expressed opinions to that effect. The trial resulted in conviction. A second trial was granted, which resulted in conviction and subsequent death of the prisoner. Through the efforts of the special attorney hired to prosecute, the family were induced to refuse an autopsy by an appeal to their superstitions. Prendergast's paternal grandfather had been insane. The unanimity with which experts retained by the prosecution arrived at the conclusion that he was insane and a paranoiac left no doubt as to his mental unsoundness. The following data were obtained by myself: Height, five feet seven inches; weight, 132 pounds; hair, red, coarse, and stiff, very little upon face. Nose fairly normal, thin at bridge, broad at alæ. Ears large and projecting, lobes short and broad, tragi both well developed; helix broad, with typical tubercles at the upper and outer border of the ear. Lips, upper small and thin, lower excessively developed, more prominent because of undeveloped upper jaw. Arrest of development of the bones of the face, especially at the alæ of the nose. Zygomatic arches normal, but appear prominent owing to the arrest of the bones of the face. Lower jaw normal. Forehead receding. Head sunken at the bregma; occipital region excessively developed; circumference, 22.2 inches (57 millimeters); anteroposterior 7.75 inches (20 millimeters); lateral 6.36 inches (16½ millimeters); lateral index 82, therefore extreme brachycephalic. Feet large, hands normal; fingers long and skinny. Width outside first permanent molar 2.25 inches; width outside second bicuspid 2 inches; width of vault 1.25; height of vault .75, anteroposterior 2.

Czolgosz (Fig. 22), the assassin of President McKinley, was the son of a Polish laborer imported under contract, born in Michigan and educated in a Polish Catholic school until the age of six. At this age he was taken from school, put to work in a foundry, and forced by his stepmother to cook his meals. The utmost efforts of government detectives do not show any violation of major or minor morality until the assassination. He was a worker in the mills of the steel trust, and lost his place through one of the mills being shut up by the trust to limit production. During the campaign of 1896 he supported the doctrine of protection as an

expression of state socialism. He accepted the statement that the mills would be opened on the election of McKinley in good faith. During 1900 he became affiliated with the extreme state socialists. While studying anarchistic literature and proclaiming himself an anarchist, he still retained a belief in state socialism. He made a demand upon McKinley for work, which he says was refused. According to the statements made to Drs. Putnam and Crego, he had always enjoyed good health. This, however, is no evidence *pro* or *con* the existence of mental disorder based on cerebral deformities. Indeed, paranoiacs and degenerates are often not only noted for their good health, but many of them for longevity. The crime bears no evidence of mental disorder on the one hand, nor is it contradictory thereto on the other. A Pole trained in Polish history in schools where American doctrines were not taught might have committed just such a crime. As a product of the man's environment, it would not have the morbid significance the like crimes have among the English and the American of the Northern United States. While the brain has been pronounced healthy, still it is a significant fact that no microscopic examination worthy the name has been made. It is admitted by E. A. Spitzka that the brain presented anomalies. The trial was purely formal. The prisoner's attorneys, yielding to popular prejudice against their client, did not secure the delay which a case of such importance required. As in the Prendergast case, the warden of the prison pandered to superstitions anent the dead and refused to allow the removal of the brain for microscopic study.

FIG. 22—Czolgosz.

The best attainable photograph of the assassin reveals suggestive stigmata. A line drawn through the face at the median line reveals marked lateral asymmetry. The left ear is considerably higher than the right. The left eye is higher and larger than the right. There

is decided difference between the size and shape of the two orbits. The left is large, round, and full; the right is small, with the outer angle much contracted. The inner border of the eyelid drops considerably. The most marked asymmetry occurs in the cheek bones; the left is much larger and more prominent than the right. The lower part of the face is fairly normal. The skull has kephalonoid tendencies.

The examination of his mental condition was simply negative and valueless for scientific purposes. It is perfectly easy to destroy all expressions of insanity by arousing suspicion. Sane or insane, Czolgosz, suspicious of all legal procedures, would be an exceedingly difficult subject with which to deal. The course of the court in refusing to accept his plea of guilty and forcing him to accept counsel is justifiable only on the ground of assumed insanity. There is no reason to believe him insane, but the logic employed to prove his sanity was not altogether scientific.

The first feature that strikes one on analysis of these cases is that with the exception of Clement, Guiteau, and possibly but not certainly Fieschi, the moral imbecile element is not specially prominent. In both Clement and Guiteau the salacity vicaration of religion was evident. Both displayed a tendency to confidence operations. In the others, the conception leading to the assassination was, except in the case of the English assailants of Queen Victoria, altruistic in nature. The notoriety element which is so prominent in puberty lunatics was especially dominant in the English cases, and to a certain extent in Guiteau. The use of a socialistic cry to cover other designs was evident not only in the case of Nobeling, but also in the case of Berezowski, who shot at the Czar during the 1867 Exposition. In both cases Polish projects rather than socialism was the inspiration. In Verger and Galeote religious reform within the church was attempted by devout though insane priests. They, however, had forgotten their oath of obedience to constituted authorities. In the case of the assassin of Canovas, a desire to end illegal methods employed against anarchists prompted the crime. The assassination of Carter Harrison forced track elevation to the front, and thus indirectly saved many lives.

The frequency of facial asymmetry and allied arrests of development among assassins whose crimes seem the direct outcome of their environment, and hence not abnormal, is rather striking. This is peculiarly impressive in the case of Fieschi, whose crime from his training in Corsica would seem perfectly justifiable. The frequency of kephalonic and allied types of skull is also rather striking when

the fact is remembered that this is often due to healed hydrocephalus. The claim that the insane do not have accomplices is shown to be erroneous; indeed, the existence of the clinical type, transformed insanity, negatives this claim. The uselessness of capital punishment as a deterrent is evident in the fact that the assassination of Carnot was followed by several other anarchistic attempts despite the execution of Santos in the teeth of the evidence of his insanity.

REPRINT FROM

The Dental Era.

VOL. III. ST. LOUIS, MO., JUNE, 1904. No. 6.

ORIGINAL COMMUNICATIONS.

The Stigmata of Degeneracy Among the American Criminal Youth.

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The fact is too often lost sight of that causes which produce abnormal development (stigmata) in one particular part of the body or of a structure also produce them in any one or all the other structures. In order to ascertain the number of stigmata in a given set of individuals and their relation to another set of individuals, it is necessary to study systematically certain classes and compare them with other classes. The most striking class of degenerates upon which to study stigmata are the criminal youth, since the period of adolescence is the greatest extra-uterine period of stress, when the great function of race increase is developing parallel with the great functional development of the central nervous system.

The present contribution results from studies on young criminals made during 1895-96 at the State reformatories at Pontiac, Ill., and Elmira, N. Y. The investigation concerns especially the stigmata of the head and face. The stature and weight were noted, but other anthropometric data were not specially considered, as measurements had to be entrusted to others. It was therefore deemed advisable to avoid as far as possible elements of error concomitant on extensive detailed anthropometry. Only simple measurements easily obtained with accuracy were made. Inasmuch as facial and cranial developments are, as a rule, most directly

TABLE 1.—Averages of stature and weight according to age and nationality of the

Averages of stature and weight according to age and nationality of the inmates

Age.	Americans.			Germans.			Irish.			Africans.			Jews.			Polish.			English and Canadians.		
	No	H.	W.	No.	H.	W.	No.	H.	W.	No.	H.	W.	No.	H.	W.	No.	H.	W.	No	H.	W
16	1	66	100	1	68	133½	. .	. .	. .	. .	. .	. .	. .	. .	. .	1	61	120	. .	. .	. .
17	15	65	122	6	64	126	20	63	112	5	66	134	4	63	110½	. .	. .	. .	4	65	122
18	19	63	121	15	64	118	30	64	119	3	64	127	7	66	125	1	61½	106	6	68	140
19	32	64	128	36	65	125	36	64	128	3	67	127	7	63	129	2	66	138	13	64	126
20	30	65	129	24	65	128	50	65	124	5	65	137	9	64	126	1	65	129	5	65	120
21	61	65½	130	30	65	117	54	65	128	10	66	131	6	65	139	1	65½	148	7	64	122
22	23	65	134	25	65	133	38	66	135	8	66	139	8	66	149	. .	. .	. .	8	65	132
23	20	66	129	16	65	132	33	66	133	4	66	133	8	61	120	1	72	160	8	65	127
24	17	66	135	15	66	130	11	64	129	2	66	155	2	66	124	1	58	100	6	65	136
25	9	67	134	8	64	127	8	67	142	1	68½	106½	2	65	142	1	67½	114	8	64	147
26	7	64	129	6	65	133	7	64	132	. .	. .	. .	5	66	144	. .	. .	. .	3	66	135
27	5	66	137	2	67	107	5	67	158	. .	. .	. .	1	66¼	116	. .	. .	. .	1	66	129
28	7	67	141	1	63	121	3	65	120	1	65¾	150½	. .	. .	. .	. .	. .	. .	1	70	152
29	4	64	134	4	64	126	1	66	150	1	64	123	. .	. .	. .	. .	. .	. .	. .	. .	. .
30	4	65	134	1	65	134	4	66	139	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .

co-related with moral and intellectual evolution, it was deemed natural that they should furnish sufficient data for discussion in an article of the present scope.

Since the inquiry dealt only with the physical stigmata of the head and face, the youngest inmates were, for obvious reasons (immature jaw and face development), excluded from consideration. The object of the inquiry was to determine the extent to which the youthful criminal came from the ranks of the degenerate. The question whether a criminal type distinct from other degenerate types exists does not enter into the scope of this paper and has not been considered. Besides, the stigmata, age and race are included in the inquiry and discussion. Details as to parentage, heredity and antecedents would have been of interest, but could not be obtained with any accuracy. Certain data naturally lead to inference unnecessary to point out—for example, the predominance of the foreign-born and those of foreign parentage, especially of certain nationalities.

nmates of the Illinois State Reformatory at Pontiac, Ill. Stature given in inches, weight in pounds.

French.			W. Indian and Mexican.			Dutch.			Scandinavian.			Slavonic. Bohemian. Russian.			Swiss.			Italian and Spanish.			Hungarian			Scotch.		
No	H	W.	No.	H.	W.	No.	H	W.	No	H.	W.	No	H	W	No.	H.	W.	No	H.	W.	No.	H.	W.	No.	H.	W.
3	65	140																1	61½	118						
						1	63	108	1	65	115	1	65	127½				6	66	148						
			1	66	130	1	69	130	1	64	114							3	67	137				6	64	112
7	66	135										1	70	185				2	66	118	1	64	104	2	68	99
4	61	125				1	62	107				1	64½	108				1	64	135	1	65	120	5	64	122
4	65	131	1	66	134				9	69	188	1	68	183				5	63	116				8	66	189
1	64	131	1	63	104	1	64	130				1	68	135	1	64	121	4	63	131	1	62	116	8	66	118
3	65	134													1	68½	141	2	68	147	1	65	138	2	66	124
						1	68	119	1	67	129													2	66	130
						1	63	150										1	65	122						
									1	61	133															
1	68	134										1	62	134										9	69	167
1	65	141																1	68	136						
																								1	68	147

The details as to those of foreign and native parentage mixed would have been of special interest for purposes of comparison. The mass of the youth examined came from the unskilled laboring class and from the urban as distinguished from the rural population. These facts are to be recognized when it is remembered that the two institutions are hundreds of miles apart and draw their population from differing communities. The two institutions have therefore been considered separately, to eliminate elements of error. The total number examined was 414 at Pontiac and 1,018 at Elmira. The ages ranged between 15 and 30 years. The average at Pontiac was a little over 19, and 21 at Elmira. For purposes of comparison, records were made as to weight and stature, and these were tabulated according to age, nationality and color. Only three or four nationalities are represented sufficiently to be of value for statistical purposes. The others are given for the sake of completeness. The nationalities were tabulated by considering those of foreign parentage on both sides as foreigners and those with one

American parent as native-born. This was thought a better course than designating nationalities by places of birth. It was thought desirable to classify certain individuals by race rather than nationalities, but this was very difficult. For example, the Jews in Pontiac are included among the Germans and Poles. Pontiac contained one full-blooded Indian, but many of the negro inmates had a considerable proportion of Indian blood. The negroes included all with an appreciable negro taint, but full blacks were in the minority. The two institutions differ in their constituents. Pontiac is more particularly a reform school and receives a larger number of misdemeanants, whom in New York are sent to Westchester, Rochester, etc., rather than to Elmira. From the tables it will be evident that an older class is received at Elmira. In tabulating, only those inmates of Elmira of 30 years and under are included; in Pontiac the oldest is 26. The first table gives data as to age, stature and weight in the two institutions. This table does not include the whole number examined, since it was impracticable in a few cases to obtain weight and stature, while obvious stigmata could easily be tabulated.

The most striking fact shown by these tables is the inferiority in physique of the Elmira inmates as compared with Pontiac. The latter compare very well with the average urban population, and still more favorably in these particulars with the artisan class of the larger English towns.* This is due to the fact that the degenerates and less active unskilled artisans of European cities locate on the sea border, while the stronger seek the interior of the country. The more apathetic emigrants of both urban and rural European communities are dragged into the cities.

In considering the difference between the inmates of Elmira and Pontiac the fact should be remembered that for several decades subsequent to 1850 New York State maintained the suicidal policy of having an establishment especially for emigrant defectives on Ward's Island. At the end of five years' residence the epileptic, hysteric, pauper, prostitute and semi-criminal classes were turned loose to drift into city institutions or to remain in the city itself. The insane and idiotic were directly turned into the New York City institutions. The defectives less than five years resident in the United States were returned from other States to Ward's Island, thus causing an undue accumulation of defectives

* Roberts' Manual of Anthropology.

TABLE 2.

Nationalities.	Illinois State Reformatory.			New York Reformatory.		
	Number.	Stature.	Weight.	Number.	Stature.	Weight.
Americans . .	59	66.18	145.5	166	65.69	128.24
Germans . . .	36	65.5	141.1	180	65	119.84
Africans . . .	28	65.8	141.1	82	65.28	132.9
Irish	47	65.88	142	209	65.2	130.4
English	14	65	138.42	41	64.97	127.29
French	6	66	149	16	64.7	134.88
Bohemian . .	6	66.67	142	4	64.87	124.25
Scandinavian.	5	69	164.2	4	67.75	132.75
Scotch	3	65	150	18	65.88	130.5

This table is intended to give only the adult averages.

TABLE 3.—CEPHALIC INDEX.

Nationalities.	Illinois State Reformatory.			New York State Reformatory.		
	Max.	Min.	Ave.	Max.	Min.	Ave.
American	80	61	72 8	79	66	73+
German	79	62	72	84	68	74
German Jew	71	. . .	71	. . .	. . .	. . .
Irish	81	68	74	86	68	78
African	71.5	59.5	71	77	68	73+
English	77	68	73	77	68	72+
French	77	71	73	75	68	73+
Polish	76	71	73.3	75	71	74
Swede	74	68	71	74	71	72
Norwegian	77	71	73	74	. . .	74
Danish	71	. . .	71	77	74	75+
Indian	73	. . .	73	. . .	. . .	. . .
Greek	71	. . .	71	. . .	. . .	. . .
Mexican	71	. . .	71	74	71	72+
Bohemian	81	71	74	77	70	72+
Swiss	74	. .	74	74	71	72+
Scotch	74	73	73	80	68	71+
Spanish	. .	. . .	. . .	77	68	72+
Jew	76	73	74	84	71	72+
West Indian	. . .	. . .	. . .	73	. . .	73
Italian	. . .	. . .	. . .	77	68	70+
Russian	. . .	. . .	. . .	68	. . .	68
Hungarian	. . .	. . .	. . .	80	73	76+

in New York City. The mere existence of the Emigrant Refuge led to the settlement of the less energetic immigrants directly in New York City. The ordinary tendency of careless charity had its usual effect in increasing the defective population of New York City, and hence of increasing the number of defective youth.

The number at the younger age in Elmira is too few to be compared with the results of Bowditch, but, so far as they go, compare favorably. The New York figures underrun Roberts' results at nearly all ages and in nearly all nationalities. The difference is more marked in weight than stature, while very apparent in the latter. The American figures indicate that the rush and roar of city

life attract active degenerates from the country, the more apathetic urban degenerates remain in cities, while the more active press Westward. In a general way, the comparison between Elmira and Pontiac tends to show that the more robust and restless of the degenerates, as well as of the Eastern rural population, press Westward. It is certain, from the studies of the defective classes, that apathetic defectives, like paupers and prostitutes, have less tendency to wander.* The more active defectives, like the paranoiacs, periodical criminals, etc., have a tendency to wander. The influence of climate and soil has been too recently exerted to be demonstrable in the difference between New York and Illinois.

Table No. 2 shows the difference between the reformatories more strikingly than can be done by words alone. In it the average stature and weight according to nationalities of inmates over 20 years of age are given. This table includes the adult averages only. It is possible that the stigmata of lipomatosis have to be considered relative to the question of weight. The difference in weight between the two reformatories is particularly noticeable. The inmates of the Eastern reformatory are generally a more slender type. In considering the question of lipomatosis the fact should be remembered that the cases admitting of this possibility are comparatively few, and the light individuals are much more numerous. The range in this particular is much more evident in Elmira than at Pontiac. As regards stature, the range was much greater at the latter place. It would be too strong a statement to claim the influence of Western soil in this particular, as has been done by some criminal anthropologists. Data of comparison with the stature of the races are wanting.

The cephalic index is one of the most interesting of the anthropologic data. The results at both Pontiac and Elmira are summarized in table No. 3. The marked dolichocephalic in both institutions is very noteworthy. As it contrasts with the marked mesocephaly of the populations from whence these criminals are drawn, it is clearly a stigma of degeneracy. This is true even of the negroes, since in 2,000 examinations I found but six instances of dolichocephaly in Chicago. The Irish in Pontiac and the Germans in Elmira appear to be the least dolichocephalic, though their average index is decidedly below the lowest mesocephaly. In a general way this result tends to confirm the opinion expressed as

* Eighth Annual Report Massachusetts Board of Health.

TABLE 4.

to the proclivity of the apathetic foreign degenerate to remain on the seaboard. It is notorious that the more active Irish of the rural class go Eastward. The more apathetic of the Germans remain in the seaboard towns. In no case could there be said to have been notable exaggeration of the racial type. It is unfortunate, however, that the cranial index of the districts from which these populations were drawn could not be obtained. Both Ireland and Germany are still dotted with dolichocephalic colonies.*

The fourth table gives the breadth of the upper jaw, measured from the outside of the first permanent molars and corresponding measurements from the second bicuspids. This will aid in giving an idea of facial proportions and average contours of the dental arches.

The fifth table shows the variations in the height of the palatal

* Taylor, Origin of the Aryans.

vault. The width of the jaws between the molars and bicuspids of the four or five leading nationalities at Pontiac was decidedly in excess of the corresponding width at Elmira. This indicates that, notwithstanding the younger age, the face was wider and squarer than at the Eastern institution. The Elmira measurements average less than those of normal individuals* in the Eastern States. The Pontiac institution's average equals, or even exceeds, the normal figure. By this fact the impression that the immigrant of better physique goes Westward is confirmed. The height of the palatal vault averages a little higher at Elmira than at Pontiac. This fact, taking into consideration the importance that has been attributed to the height of the vault as a stigma of degeneracy, is of decided interest. The difference, however, between the average of the two reformatories is too slight to be of much value, even were it certain that height of the vault had the importance attributed to it. As compared with what may be considered the normal vault,† the average height in both Elmira and Pontiac may be considered under the normal, but much importance cannot be attributed to the slight difference. The measurements of the width of the jaws and of the height of the vault are, in the aggregate, of value, but their range above or below the normal is not remarkable.

A series of measurements was taken between the eyes, measuring from center to center of the pupils, 2½ inches being the average. More accurate figures would have been obtained had the measurements been made between the inner and outer canthi. The variations between the reformatories themselves and between them and normal communities are not very striking.

The more accepted stigmata of degeneracy present striking facts in these institutions. It is advisable first to establish a normal standard, remembering that the average individual possesses degenerative stigmata to a minor degree, and that only combination and excess in a number of these mark the degenerate in the higher sense of the term. To furnish a normal standard a series of persons representing the average of the community was selected and note taken of their stigmata, especially in the head and face. They were city residents of respectable standing, and were taken at random. The total number was forty-two. Of these, fifteen had subnormal and seven excessive development of the occiput; two

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* Etiology of Osseous Deformities, 1894.

† Idem, page 74.

TABLE 5.

Nationalities.	Illinois State Reformatory.			New York State Reformatory.		
	Greatest height of vault.	Least height of vault.	Average.	Greatest height of vault.	Least height of vault.	Average.
American	.63	.44	.49	.75	.50	.54
German	.75	.42	.50	.75	.50	.52
German Jew	.62	.50	.50	...	...	...
Irish	.62	.50	.56	.75	.50	.54
Negro	.62	.50	.52	.87	.50	76
English	.62	.50	.55	.75	.50	.58
French	.62	.50	.55	.75	.50	.58
Pole	.62	.50	.52	.62	.50	.54
Swede	.60	.50	.52	.62	.50	.58
Indian	.60	.60	.60	...	...	...
Greek	.62	.62	.62	...	...	...
Bohemian	.62	.50	.51	.50	.41	.48
Norwegian	.62	.50	.54	.62	.62	.62
Swiss	.62	.62	.62	.56	.50	.53
Danish	.62	.62	.62	.75	.50	.62
Scotch	.62	.44	.57	.62	.50	54
Jew	.56	.50	.54	.75	.50	.54
West Indian	...	...	...	.50	.50	.50
Mexican	...	...	...	.62	.52	.57
Italian	...	...	...	.62	.50	.57
Spanish	...	...	...	.75	.41	.63
Russian	...	...	...	.50	.50	.50
Hungarian	...	...	...	.62	.50	.59
Dutch	...	...	...	.75	.50	.58
Turk	...	...	...	.50	.50	.50
Tyrol'	...	...	...	.62	.62	.62
Roumanian	...	...	...	.62	.62	.62
Canadian	...	...	...	.75	.50	.58

TABLE 6.—Number of stigmata of degeneracy of entire body, in the Illinois State Reformatory.

No. of stigmata.	American.	German.	Negroes.	Irish.	Jew.	Polish.	English.	French.	Indian.	Swede.	Greek.	Mexican.	Bohemian.	Norwegian.	Swiss.	Danish.	Scotch.	Dutch.
9	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
11	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	...	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
13	1	...	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14	8	...	5	8	...	...	1	...	...	...	...	...	...	...	...	...	...	1
15	3	2	5	...	...	...	1	2	...	...	...	...	...	...	...	...	2	...
16	4	1	6	3	...	...	1	2	...	...	...	...	...	...	...	...	...	...
17	9	1	1	5	...	1	2	1	...	...	...	...	...	...	...	...	...	...
18	11	13	8	12	...	1	2	1	...	...	...	...	1	...	...	...	1	...
19	24	10	8	18	2	8	4	...	...	8	...	...	...	1	...	...	...	...
20	18	12	6	9	...	3	6	1	...	8	...	...	...	...	...	1	...	1
21	28	11	8	10	...	1	8	8	1	1	1	...	...	1	...	...	...	1
22	11	8	8	15	...	1	4	1	...	...	...	1	1	...	1	...	...	...
23	4	4	1	10	...	...	...	...	...	...	...	...	1	...	...	...	...	...
24	2	...	1	5	...	...	1	1	...	1	...	...	...	1	...	...	...	...
25	2	2	...	2	...	1	...	...	...	...	...	...	...	...	...	...	...	...
26	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1	...
28	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Aver:	22.1	19.7	17.	21.8	19.	20.	18.5	18.6	21.	21.	21.	22.	21.	21.	22.	22.	18.7	18.8

had the bregma abnormally depressed; four had very low and three receding foreheads; nineteen had an arrested and seven excessive facial development; three had the nose sunken at alae; twenty-six had arrested and three excessive nasal development; one had the septum strongly deflected to the left; ten had abnormally small and eleven very large orbital cavities (many of these also had the eyes sunken); four had V-shaped jaws, two partial V, seven saddle-shaped and two semi-saddle-shaped jaws; six had irregular dentition; one hypertrophy and atrophy of alveoli; twelve had very large and two abnormally small development of the thyroid gland; not less than thirty-nine had one or more aural defects—either two large or too small, too widely or two closely set ears, adherent or excessive lobules, Darwin's tubercules, etc. Of the whole number there were only two with four stigmata each, one with five, six with six, seven with seven, six with eight, five with nine, four with ten, five with eleven and four with twelve stigmata. The average number of each individual was eight, and this may perhaps be accepted as approximately the normal figure, at least for the ordinary urban resident who does not belong to the defective classes.

Differences of opinion may arise in regard to the value of these defects as stigmata; yet, all elements of error considered, they furnish a fair method of comparison of the relative degeneracy of the respectable community and of the reformatory. Tables Nos. 6 and 7 show that the stigmata of the average inmate of the reformatories are nearly double that of the average normal individual. In the New York institution the stigmata are double or more in nationalities of any number of those in the Illinois institution. Hence the stigmata follow the same general rule as the physique. The inmates of the Illinois institution are noticeably less stigmatized by degeneracy than the New Yorkers. The native Americans of the New York institution presented an average of sixteen stigmata each. Those in Pontiac had only fourteen. While the difference was not so marked in the other nationalities, it was still sufficiently apparent. This corroborates the conclusion that the more defective degenerates remain on the sea border.

While stigmata other than those of the face and head were not considered at any length in the studies for this paper, still the majority of the inmates were found to present an abnormal proportion of them. Marked bodily asymetries, disproportion of members,

TABLE 7.—Number of Stigmata of Degeneracy of Entire Body in the New York State Reformatory.

No. Stigmata.	Americans.	Germans.	Negroes.	Irish.	Jew.	Polish.	English.	French.	West Indian.	Swede.	Mexican.	Bohemian.	Norwegian.	Swiss.	Danish.	Italian.	Spanish.	Russian.	Hungarian.	Scotch.	Dutch.	Turk.	Roumanian.
9	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
10	. .	. .	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
11	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
12	. .	. .	. .	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
13	1	2	. .	1	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
14	5	3	1	3	2	. .	. .	. .	. .	. .	1	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
15	10	4	. .	14	1	. .	4	1	. .	. .	. .	. .	1	. .	. .	1	1	. .	. .	. .	. .	. .	. .
16	9	11	6	14	5	. .	7	3	. .	. .	. .	. .	. .	. .	1	3	. .	. .	. .	. .	. .	. .	1
17	22	16	5	12	4	1	7	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	1	1	. .	. .
18	30	20	6	21	5	1	5	2	. .	. .	. .	1	. .	. .	. .	3	. .	1	1	3	. .	1	. .
19	31	26	5	43	6	3	7	2	. .	1	. .	. .	. .	. .	. .	8	. .	. .	2	1	. .	. .	. .
20	46	34	11	64	13	3	13	4	1	1	. .	. .	1	. .	1	1	1	. .	. .	. .	. .	. .	. .
21	36	36	3	59	10	1	18	5	. .	. .	. .	2	. .	1	1	6	1	1	2	5	1	. .	1
22	27	19	6	33	5	1	4	3	. .	. .	. .	. .	. .	. .	. .	1	1	. .	. .	3	1	. .	. .
23	13	10	. .	13	2	. .	3	2	. .	. .	1	. .	. .	1	. .	1	1	. .	. .	1	. .	. .	. .
24	7	5	. .	4	. .	. .	4	. .	. .	. .	. .	. .	. .	. .	. .	1	. .	. .	. .	1	1	. .	. .
25	3	. .	. .	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	1	. .	. .	. .
26	1	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
27	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
28	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
Average.	20 -	19.4	18.8	17.2	19.2	19.5	17.7	19.5	20	20	17.5	20	17.5	22	19	19.3	20.2	19	15.4	20.7	21	17	18.5

flat feet, were more common than in the average normal population. Though reformatory inmates are usually considered as somewhat distinct from the ordinary population of the penitentiary, they present many of its physical characteristics. In this connection some recent studies of Dr. Charles E. Woodruff, of Fort Custer, Montana, which are to form the basis of a work on degeneracy in regard to military service are in point. Dr. Woodruff* remarks: "It is not often that criminals are enlisted, and the records, if gone over, will probably show that the number of crimes committed by soldiers is far less than those committed in any community among an equal number of young men. If a city has 20,000 young men, say, of ages from 20 to 35, it is quite possible that it has over 200,000 inhabitants, and I know of no city of that size where there are so few thefts and serious crimes as in the army. This should have been expected from the exclusion of the worst degenerates by the physical examination. A large number of common stigmata unfit the person for military service, and as criminals were believed to be physically below normal, this I made a personal test to determine. Through the courtesy of Superintendent R. W. McClaughry, of the Illinois State Reformatory, I examined 138 young convicts, just as I would recruits. I excepted the hearing and eyesight, as these

* Degeneration in Military Life.

tests are subjective, and their notoriously untruthful answers could not be accepted. As eye and ear affections are known to be quite common, there would have been more disability for these troubles had time permitted of examination by objective methods.

They were divided into the following classes:

1. There were only two in whom there were no discoverable defects, there were two others with very trivial defects, and ten more who would pass but might be rejected by a careful surgeon; total, fourteen.

2. In this class were placed those having minor defects sufficient to reject an unknown recruit, but which the surgeon himself would feel justified in overlooking if the man were very desirable (a good mechanic, clerk, etc.), or in the case of re-enlistment; total, thirty.

3. In this class were defects so serious that the surgeon would not feel justified in overlooking, but would recommend that special authority be asked to enlist the man if he were extremely useful or were needed for special service, not in the ranks, or were needed in war; total, thirty-seven.

4. Defects which would exclude in peace times, but would permit of special service (clerk, messenger, etc.) in time of war; total, thirty-three.

5. Totally unfit, either in peace or war, for special or general service; total, twenty-four. Aggregate, 138.

Several very boyish, immature men, evidently too young, were not included, nor were negroes. It must be remembered that these are the best grades of criminals in whom the judge believed there was chance for reform. Some of them are normal men who have been in bad surroundings—that is, they were taught to be criminals. The physical defects of confirmed criminals in penitentiaries are more marked; and from a very imperfect and casual examination of those in Joliet prison I believed that very few were capable of military service.

Then, again, quite a large number of criminals cease their active careers as executors of crime at the age of 25 or thereabouts and then become contrivers of crime, directing others—they are capitalists of crime, running brothels, saloons, become "fences," etc. Therefore, at the age at which the majority of men enlist in the army the criminal is too actively engaged to think of enlisting. When one does slide in by oversight it is surprising how quickly the soldiers of his company take measures to get rid of him. In

TABLE 8.

	Head.								Face.							Nose.								
	Occiput.			Bregma		Forehead.			Developm'nt.			Zygomata.				Width.		Length.		Developm'nt.			Septum	
	Arrested.	Excessive.	Normal.	High.	Low.	High.	Low.	Receding.	Arrested.	Medium.	Excessive.	High.	Medium.	Low.	Sunken at alæ.	Broad.	Narrow.	Long.	Short.	Arrested.	Medium.	Excessive.	Deflected to left.	Deflected to right.
Illinois State Reformatory	258	88	127	349	110	295	158	. .	285	188	42	298	121	51	128	188	258	268	171	69	892	4	106	36
New York State Reformatory	412	496	183	952	89	646	205	190	586	80	425	398		116	419	421	610	580	461	751	12	278	80	11

	Jaws.							Teeth.				Alveolar Process.			Thyroid Gland.			Arms.		Hands.				Legs.		Feet.		
										Tubercles.			Abnormal.															
	V-shaped.	Partial V.	Semi-V.	Saddle.	Partial saddle.	Semi-saddle.	Normal.	Irregular.	Irregular.	Present.	Absent.	Normal.	Hypertrophy.	Atrophy.	Normal.	Excessive.	Arrested.	Long.	Short.	Long.	Short.	Right-handed.	Left-handed.	Long.	Short.	Large.	Small.	Medium.
Illinois State Reformatory	75	71	8	66	68	16	171	128	342	18	452	871	98	1	155	178	187	327	136	326	187	424	41	327	136	87	106	360
New York State Reformatory	381	49	1	157	26	. .	422	220	821	96	1,015	968	73	. .	106	909	86	659	892	659	892	904	47	659	892	4	892	655

some years the recruiting officers reject as many as 90 per cent of the candidates for enlistment, only 10 per cent being found up to the proper standard. In that 90 per cent will be found the worst degenerates. It is rare to have more than 25 per cent accepted.

It is reported that forty newsboys were taken to the Brooklyn Navy Yard to enlist and that thirty-eight were rejected as physically unfit.* This is to be expected when we reflect that these boys are thrust into the street as a result of parental degeneration and must be degenerates of bad type and of markedly inferior physique. We have already called attention to the large number of criminals who have hernia (over 10 per cent), tubercular history (perhaps 50 per cent), and heart disease (25 to 50 per cent), shortness of stature, underweight, defective senses and intelligence, and a restlessness incompatible with military discipline. From all the above facts I would make a rough estimate that 95 per cent of confirmed criminals are physically unfit for military service."

Knock-knee and flat-foot have not usually been considered stigmata, but deformities, due to mechanical changes and sometimes due to perverted development of the bones. The conditions usually go together, for it is rare to find flat feet in bow-legged men. Flat-foot and knock-knee are much more common among degenerates than is usually supposed. In the 141 criminals I examined in Pontiac there were the following deformities of all grades:

Feet and knees normal	67	47.5	per cent.
Knock-knee alone	14	10.0	"
Flat-foot alone	34	24.1	"
Knock-knee and flat-foot combined	22	15.6	"
Very bow-legged	1	.7	"
Bow-legged and flat-footed	3	2.1	"
	141	100	

From the lack of resistance of degenerate structures, one should be prepared to find, therefore, that more than half of these men should present anomalies of the feet and knees. I have very frequently been astonished at the high degree these deformities assumed in undesirable recruits. I kept no record of the number of the above cases in which the deformity was of sufficient grade of itself to unfit for military service.

Ancient statuary is remarkable for the number of flat feet, in

* Medical News, June 20, 1897.

TABLE 9.—Aural measurements and variations.

	Length.								Width.									Helix.								Anti-helix.		
																		Development.			Form.			Root.		Development.		
	1¾	2	2⅛	2⅜	2¼	2½	2¾	3	⅞	¾	1	1⅛	1⅜	1¼	1½	1¾	2¼	Arrested.	Medium.	Excessive.	Folded.	Medium.	Open.	Normal.	Abnormal.	Arrested.	Medium.	Excessive.
Illinois State Reformatory.	1	18	6	5	90	248	83	16	2	1	66	105	17	221	45		1	286	55	174	181	48	236	157	808	195		270
New York State Reformatory.		15	3	4	205	682	118	17		1	34	170	156	608	70	3		771	52	206	294		747	907	184	817	13	723

Tubercles of Darwin.							Lobule.									Tragus.			Anti-tragus.			Concha.			Angle.			Relation.		
Middle third.		Upper third.		Lower third.		None	Attachment.			Shape.			Development.			Development.			Development.											
Right.	Left.	Right.	Left.	Right.	Left.		Close.	Medium.	Separate.	Broad.	Narrow.	Long.	Arrested.	Medium.	Excessive.	Arrested.	Medium.	Excessive.	Arrested.	Medium.	Excessive.	Large.	Small.	Deformed.	Close.	45 degrees.	Right.	Right, higher.	Left, higher.	Normal.
195	167	70	47		2	307	309	163		334	104	33	255	12	198	117	244	124	810	59	76	92	187	305	198	152	115	51	98	891
809	285	82	80	2	1	701	831	191	19	671	361	35	481	25	513	584	70	427	698	21	316	657	266	118	285	567	187	1	2	[illegible]

which the arch is in various grades of destruction. Ancient models have been very poor to cause the artists to copy this condition so often.

As a mild form of knock-knee is a normal feminine characteristic, we find it well marked in cases of femininism. The mild grades of flattened feet in women are also in part normal, and follow quite naturally weak tissues. Both conditions in males may, then, be a result of femininism. The infant's foot is normally flat, and so is the negro's, and its retention in adults may be atavistic. In the Elmira reformatory, of 529 men examined, the arch of the foot appeared to be normal in 58.42 per cent, unnaturally low in 18.71 per cent, and flat in 22.87 per cent.

Faulty condition of the foot may be produced by an anomalous position of the ends of the long bones of the leg and thigh. The toes may be thrown far out, causing a shuffling gate, as though the man walked on his heels; or the toes may be turned in. In civilized man the feet make an angle of about 30 to 45 degrees, but in many savages it is a smaller angle, or, indeed, the feet may be parallel.

All the above states of the knees and feet must not be considered stigmata, as they are not always due to unstable development; but they may be given weight as indicating faulty development of the tissues, a degenerate characteristic. It is quite likely that the fault is rickets, which recent investigations have proved to be almost the rule in degenerate children.

There can be no doubt that similar systematic research would reveal among the older criminals in the State prisons an exceedingly large proportion of degenerates, as indeed incidental research has shown. There have, however, been very few systematic studies of the younger criminal as a class, or of those who for various reasons have been found by judges better suited for reformatories than true penal establishments. The few examinations that have been made were generally of a more juvenile class than that here considered, and hence not well suited for the study of stigmata. The notes on the stigmata involved a greater number than are represented in the other tables. This, as has already been explained, was due to the measurements being made by others. There is no doubt, however, as to their substantial accuracy.

No attempt was made at systematic craniometric data, the chief aim of the observations having been to note the facial stigmata. In a general way some more striking cranial deformities are

TABLE 10.—Crime.

	Illinois State Reformatory.	New York State Reformatory.
Burglary	263	499
Larceny	154	. . .
Murder	8	2
Rape	3	10
Assault to kill	10	. . .
Forgery	12	65
Grand larceny	12	309
Arson	1	4
Abduction	1	2
Malicious mischief	1	2
Violation of postal laws	2	4
Perjury	1	2
Horse stealing	2	. . .
Confidence game	1	. . .
Assault	. . .	42
Crime against nature	. . .	1
Robbery	. .	68
Manslaughter	. . .	2
Bigamy	. . .	6
Receiving stolen goods	. . .	16
Possession of counterfeit certificate	. . .	1
Violation of election laws	. . .	2
Embezzlement	. . .	2
Obstruction on railroad	. . .	2
Attempt to escape from prison	. .	2
Unlawful marriage	. . .	1

noted, the excessive or otherwise occipital or bregmatic prominence and the relative height of forehead. The most notable peculiarity in these respects is the large proportion of cases of pronounced height of the bregma, more observable in the inmates of the New York State Reformatory than at Pontiac. While not pronounced enough in all cases to result in true oxycephaly, the tendency was in that direction. This fact is in accord with observations elsewhere on the criminal classes. The excess of development in the occipital region was likewise more common in the Elmira inmates, whose proportion of average normal heads was less than that of the Western institution.

As regards the face, the tendency seems to be more commonly toward an arrested than an excessive development, especially at Pontiac, where a fairly normal facial contour is more common. The height or prominence of the zygoma, claimed as a criminal feature, was most common in Pontiac. There was no predominance of unusually large orbits (as described by Lombroso) in either place. A diminished orbital capacity was the rule, and in Elmira deep-sunken eyes were in the majority. Nasal development of moderate degree was the exception at Elmira, but the rule at Pontiac. In the more particularly known mandibular deformities the results were striking. Well-formed or normal jaws were decidedly

in the minority. The proportion of abnormalities (V-shaped, partial V-shaped, semi-V-shaped, saddle-shaped, partial saddle and semi-saddle) was excessive in both reformatories (63 per cent at Pontiac and 60 at Elmira). These deformities, common in criminals, by the flaring out of the posterior portion of the lower jaw, contribute to the square lower face in the criminal physiognomy. The teeth were only in a moderate proportion affected by irregularities aside from those connected with deformities of the jaw. The same is true of alveolar abnormalities. In both respects the inmates were fairly normal, and as regards regularity of dentition, were rather better than the average. The types of aural stigmata have been discussed in my paper on "The Degenerate Ear."*

The percentage of deformities of the kind is rather under that observed in the non-criminal population. The size of the ears was not very extraordinary. This may perhaps be due to the age of the patient, since growth of the ear is more or less continuous throughout life. The most striking peculiarity found among the juvenile criminals was the number of ears set at obtuse angles to the head, which has been noted as a criminal peculiarity by Frigerio. Although a very small number (about one per cent) had very long ears, still this percentage was a large one considering the average age of the persons examined, and therefore merits attention, since it may be an evidence of premature growth, so common in the defectives. A notable peculiarity at Elmira was the prominence of the thyroid present in nine-tenths of the inmates. In this the lesser development of the fleshy tissues played a part. The prominence included both the gland and the thyroid cartilages. At Pontiac there was nothing noticeable in this respect. The arms and legs were more excessively developed at the Pontiac institution. As a large proportion of the Pontiac inmates were otherwise well developed, this excessive development was evidently a stigma of the atavistic criminal type.

Complexion and color of eyes and hair was noted in each institution (Table 9), those of negro descent being excluded from consideration. Decided blonds furnished about 12 per cent of the inmates of Elmira and 11 per cent of those of Pontiac. The great majority were neither blond nor brunette, but had hair of varying shades of brown. An overwhelming majority had gray or blue eyes.

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*Journal of the American Medical Association, Vol. XXVII.

Black eyes were in the minority. Decided red hair was uncommon, but most frequent in Elmira (about one per cent).

The table (Table 10) giving statistics of crimes reveals no very striking difference other than accountable by the differing methods of the courts of the two States. The small proportion of pure crimes of violence (about 5 per cent at Pontiac and very little more than that at Elmira) indicates that crimes of passion were the exception, and that those offenders were more truly criminals than might have been expected from their status as reformatory inmates. As to the extent of their responsibility and reformability, it must be remembered that degeneracy predisposes the majority to become easy victims of vicious tendency. Juvenile, moreover, when not of purely infantile type, is apt to be precocious criminality. As pointed out by Ferri, it is an indication that the individual falls rather into the class of "born criminals" (in Ferri's sense) than into that of the occasional type. The occasional crime, Ferri remarks, and the crime of passion do not occur, as a rule, before manhood, and rarely or never lead to relapse. In other words, there are the slips of conduct in an individual who has developed normally in the main. These reformatory inmates, as a class, have the potentialities of the habitual criminal, of which it is the aim of the institution to prevent development. They are the victims of environment, it is true to a certain extent, but are, far more than is commonly supposed or admitted by philanthropists and reformers, the victims of heredity. Every form of ancestral malnutrition and vice has undoubtedly played its part in their development. The results of my inquiry, so far as it has proceeded, may be summed up as follows:

The inmates of these two State reformatories are, in the vast majority, of the degenerate class. Their physical stigmata are more than twice as numerous as those in non-criminal individuals. This is true in the particulars noted in the present inquiry. From Dr. Woodruff's results it is evident that further increase of the scope of the inquiry would have increased rather than lessened this proportion.

The very perceptible difference between the inmates of the two institutions as regards the degree of degeneracy shown in the number of stigmata presented is due to the causes already pointed out, and especially to the suicidal policy of New York State having so long maintained the pauperizing Emigrant Refuge. Here, as

has already been pointed out, the defective classes of the European countries were deliberately selected out to form the population of New York State, while the other States received the more robust and less degenerate members. In addition to this, the attraction of a large city naturally held the weaker members of the emigrant community, while the stronger tended away from the seaboard.

While many of the special peculiarities claimed by various authors as characteristics of the criminal class were found, still there was no such predominance of any one or more of these features that would justify the creation of a criminal type as shown by particular and generally manifested features. The sole conclusion to be drawn in this particular is that these younger criminals belong to the degenerate class and are so handicapped by hereditary defects that they fall ready victims to criminal tendencies and environment.

THE

ALIENIST AND NEUROLOGIST.

VOL. XXII. ST. LOUIS, OCTOBER, 1901. No. 4.

JUVENILE FEMALE DELINQUENTS.

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WOMEN, as Havelock Ellis* remarks, are everywhere less criminal than men. The proportion varies greatly. In France it is usually about four to one; in the United States it is about twelve to one; in Italy and Spain the proportion of women is very small. In Great Britain the proportion of criminal women is extremely large especially for the more anti-social crimes. There has been a steady increase in the proportion of women criminals in England. In 1834 they were less than one in five; but of recent years more than one in four. The greater tendency to recidivation in women everywhere noted, is extremely well marked in England where it is rapidly increasing and is associated with growing habits of alcoholism. Of incorrigible recidivists a very large proportion in Great Britain are women; forty per cent of the women committed to prison have been previously committed more than ten times. Among juvenile offenders discharged from reformatory and industrial schools as incorrigible, the proportion of girls is double that of boys.

Certain crimes both sexes commit about equally. These are usually the most serious. Thus, according to Quetelet, nearly as many women are poisoners as men and of parricides fifty per cent are women. The crimes of women are essentially domestic—against fathers, husbands and children. A very large proportion are directly or indi-

*The Criminal p. 214.

rectly of a sexual character. Marro finds marked physical resemblance between women criminals generally and male criminals guilty of sexual offences; such have lesser length of arms and hands, less cranial capacity and greater extension of the transverse curve.

There are five probable causes for sexual variation in criminality especially acting on women: First, physical weakness; Second, sexual selection; Third, domestic seclusion; Fourth, prostitution; Fifth, maternity. There are firstly the physical and psychic traditions of the race embodied in the organization of men and women. The extreme but rather spasmodic energy of men favors outbursts of violence while the activities of women are at a lower but more even level. Their avocations have tended to develop the conservative rather than the destructive instincts. Apart from this, even if women were trained in violence, the superior strength of men would still make crimes of violence in women very hazardous and dangerous. Under the existing circumstances when a woman wants a crime committed she can usually find a man to do it for her.

Sexual selection, as Marro* suggests, has exerted a marked influence in diminishing the criminality of women. Masculine, unsexed, ugly, abnormal women, the ones most strongly marked with the signs of degeneration, have the tendency to criminality and hence to a large extent passed by in the chance of a mate, would tend to be eliminated. Domestic seclusion of women is, according to Ellis, an undoubted factor in the determination of the amount of woman's criminality. In the Baltic or Teuto-Slavonic provinces of Russia, where women share the occupation of men, the level of feminine criminality is very high. In Spain the most backward of the large countries of Europe, where the education of women is at a very low level and women lead a very domesticated life, the level of feminine criminality is extremely low. The same is true to a less extent of Italy. In England which has taken the lead in enlarging the sphere of woman's work, the level of femin-

*La Puberta.

ine criminality has for half a century been rising. There is much more criminality among Irishwomen in England than among Irishwomen at home who lead a more domestic life. Women criminals according to Marro, in marked contrast to men, had in a very large proportion (thirty-five out of forty-one) more or less honorable occupations. A large proportion of the women are possessed of some property.

The separation of crime from prostitution exerts an undoubted influence in diminishing woman criminality. If it were not for prostitution there would be no alternative but crime for the large number of women who are always falling out of the social ranks. In those families in which the brothers become criminals the sisters with considerable regularity join the less outcast class of prostitutes, sometimes in league with their criminal brothers but yet possessing a more recognized means of livelihood.

The strongest warrior against criminality in women is maternity. The proportion of criminals among young women with children is very small. Among men criminal celebates are in a very large majority, but among women maternity acts as a still greater deterrent. Not only are young married women comparatively free from crime but among married women, as Bertillion has shown, those with children are distinctly less criminal than those without. Of forty-one criminal women Marro found all but one (who was undeveloped and ugly) had had sexual relationship; twelve had never been married; ten were widows; fourteen were married, but of these seven (fifty per cent) were separated from their husbands. While in men the maximum of criminality falls at about the age twenty-five, in women this is not so. While maternity has this beneficial influence, precocious and random sexual relationships have an equally grave influence in the opposite direction. The age of maximum child-bearing, the age of maximum criminality in women is delayed until nearly the age of thirty-five. In one hundred and thirty women condemned for premeditated murder studied by Salsotto, the average age was thirty-four. Marro found that for nearly every class of criminals

the average age of the women was much higher than that of the men. Woman without children is heavily handicapped in the race of life. The stress that is upon her is written largely in these facts concerning criminality. Crime simply signifies the extreme anti-social instincts of human beings. A life led most closely in harmony with the social ends of existence must hence be the most free from crime.

The prostitute, in my opinion as I have elsewhere stated,* is a parasite in whom crime has taken the line of least resistance, hence in estimating crime prostitution should be added to female criminality. The prostitute as a rule corresponds to the confidence operator of the beggar or tramp type. To a certain extent this view dominates Lombroso, who assigns as a reason for the comparative rarity of the criminal type in women the fact that they are congenitally less inclined to crime than men. Primitive woman and still more civilized women are less ferocious than men. The occasional criminal is most frequent among women. As occasional criminals have no special physiognomy they present no type characteristics. This is all the more evident since even when a born offender, woman's offences require an attractive appearance and prohibit the development of repulsive facial states. Primitive woman, according to Lombroso, was rarely a homocide but was almost always a prostitute and such she remained until semi-civilized epochs. This is why prostitutes exhibit more retrogressive characteristics than are to be observed in the female delinquent. The female criminal is an occasional criminal presenting few stigmata of degeneration but tending to multiply in proportion to her opportunities, while the prostitute has a greater atavistic resemblance to her primitive ancestor, the woman of pleasure. In short the female criminal is of less typic aspects than the male because she deviates to a less degree from the type and finally because beauty, being for her an absolute necessity in the struggle for existence, resists degeneracy.

The factors interfering with the development of the

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*Degeneracy, Its Causes, Signs and Results.

Il Donna Delinquente.

criminal type in woman are but faintly outlined by either Havelock Ellis or Lombroso. Woman from her construction is essentially much more altruistic than man. She is developed physically to secure care for another being for whose benefit she furnishes nutriment at her expense for years. This altruism has begun very early in the scale of evolution since it appears even in the fish at times, the reptiles, more frequently, the birds and oviparous mammals still more frequently and the mammals, including women, most frequently of all. Indeed the term mammal implies altruism. For this reason of which maternity is the expression, woman is guarded against deterioration of the secondary *ego* to a greater extent than man.

Another factor which aids that just mentioned is the fact generally ignored but logically cited by Lombroso, that women are not only longer lived than men but have greater powers of resistance to misfortune and grief. As G. F. Shrady* remarked nearly a decade ago, while woman has been deprived of so many rights, she has the advantage of man as regards longevity. She suffers less from accidents, injuries and many forms of disease and is in fact more tenacious than man of the limited enjoyments allowed her. As Dr. Brandreth Symonds† has shown in the first year of life the mortality of the female is much less than that of the male, being at birth 92.64 per one thousand as against 112.80 and at the end of the year 31.88 as against 35.08. This difference continues up to the fourth year. From five to twelve the female mortality is greater than that of the male, being at the latter period 3.56 for males and 4.28 for females. At the age of 46 the male mortality equals that of the female, the latter having been up to this time slightly in excess. During the years forty-six to fifty-six, the period of the climacteric, the male mortality gains rapidly on the female, being 6.32 per annum for the one and only 3.47 for the other. Hence the climacteric is really a much more serious time for man than for woman. After fifty-six the female mortality gains on that of the male,

Medical Record, Vol. XXXV.

†*American Journal of Medical Science*, May, 1894.

but is always slightly below it. Woman has not only a less mortality but a greater longevity than man. There is also a plurality of female births. In the case of the female criminal, remarks Lombroso, these conditions seem almost exaggerated, so remarkable is her longevity and the toughness with which she endures the prolonged hardships of even Italian and Russian prison life.

Prostitutes are supposed, as Lombroso remarks, to die of phthisis or syphilis in early youth, yet the weight of evidence is that many have iron constitutions, that their abject trade does not exhaust them and that they can resist anything.

(*To be Continued*).

THE

ALIENIST AND NEUROLOGIST.

VOL. XXIII. ST. LOUIS, JANUARY, 1902. No. 1.

JUVENILE FEMALE DELINQUENTS.*

By E. S. TALBOT, M.D., D. D. S.

CHICAGO.

MARION DE LORME lived to be one hundred and thirty-five (from 1588 to 1723) so that the Parisians wishing to instance something which resisted the assaults of time cited her and the tower of Notre Dame. She buried four husbands and was over eighty before losing her freshness of mind or body. Ninon de L'énclos at eighty still had as glossy black hair as in youth, white teeth, bright eyes, full form and excited a violent passion in the Abbe de Chateauneuf a youth of twenty.

Many Greek courtesans were celebrated even in old age such as Plangone, Pinope, Gnatone, Phryne and Thais. Historians maintain that Thais died at seventy without ever having abandoned her profession. Plutarch relates that she pursued a young Thessalian with whom she was in love into the temple of Venus whereupon the women of the country killed her, angry at her audacity, and jealous of her charms. Phryne when old, had lost nothing of her beauty and she exacted large sums to the day of her death, wittily describing the practice as "selling the dregs of her wine dear."

The occasions which present themselves to draw the naturally normal woman into crime are, according to Lombroso, multiplied now by the higher education conceded to females but of which they can make no use by earning their bread in offices or professions. Many women of intelligence find themseves with nothing to show in return for

*Continued from ALIENIST AND NEUROLOGIST, October, 1901.

much expense and labor. They are reduced to want while conscious of not deserving it. Being debarred from the probability of matrimony owing to the ordinary man's dislike to a well instructed woman they have no resource but in suicide, crime, or prostitution; the more chaste kill themselves, the others sell themselves or commit thefts. According to Mace, governesses are to be found in St. Lazare imprisoned for thefts of gloves, veils, umbrellas, pocket-handkerchiefs and other articles necessary for them to make a good appearance in school for whose purchase they cannot always earn enough. They have been driven to the offense consequently by the exigencies of their profession. The number of governesses who have no pupils is so great that a certificate, whether high or low class, becomes the case of suicide, of theft or prostitution.

For centuries, as J. G. Kiernan* remarks, while man was the hunter and warrior, woman was the farmer, tool-maker, carpenter, tailor, tanner, shoemaker and decorative artist. Every art of civilized nations originated with woman. When hunting and war ceased to be the chief male occupations man intruded on arts created by woman.

Evolution in biology (an advance from the indefinite homogeneous to the definite heterogeneous with the loss of explosive force,) consists in the creation of checks; these in man result in the creation of a secondary *ego*, the source of all morality. So far as the race is concerned, the creation of this secondary *ego* is most important in woman. Checks will not be created when woman is secure in the "home," gynaseum or harem from evil. Society, as Voltaire remarks, is created by women. The nations which seclude women are unsociable. Seclusion hence destroys individuality, the source of ethical advance.

The question arises whether, as seems indicated, the increase of other criminality at the expense of prostitution be not an expression of advance. In a certain sense, as even Havelock Ellis admits, this is true. Lombroso has crudely recognized the same fact. While in primitive conditions prostitution in the modern sense was exceptional since the

*Alienist and Neurologist, 1895.

woman for religious reasons or at the demand of her husband and relatives, gave herself for hire, still there was much sexual laxity consistent with tribal ethics which were not of those of civilization. Primitive man became criminal in civilization not from its degrading influence but because he was judged by new standards. Under such conditions crime would take the line of least resistance in the weak. Hence what women had formerly done for religion or at parental or family dictation, they would do for their own advantage. Under Greek civilization, the only career for cultured women was, prior to the time of Pericles, that opened by prostitution, whence came the Hetarai. To a certain extent conditions of primitive life foster the employment of sexual weapons by women as a means of securing power or even life. This condition however, while the germ of civilized prostitution, had not its abject features since the women that adopted it were rather above than below the then existing ethical standards. Under primitive and even under comparatively high Aryan and Semitic standards, woman was the property of man. Prostitution lost its immoral nature when commanded by the husband or father who had the right to dispose of his property as he would. Woman under such conditions, was guilty not of prostitution, when she gave herself either in marriage or without sexually for purposes of gain, but of theft.*

In analyzing the inter-relation of prostitution and criminality these facts must be taken into consideration.

The view that criminality was an advance on prostitution is borne out by the valuable researches of Pauline Tarnowsky† on the Russian prostitutes and female thieves. After careful analysis of the data obtained she expresses the opinion that: "Professional prostitutes are incomplete beings affected by arrest of development generally due to morbid heredity and present mental and physical signs of degeneracy in accord with their imperfect evolution. Female thieves are less tainted with heredity than prostitutes and have fewer signs of degeneracy. The intellectual and moral

*Letourneau *Evolution of Marriage.*

†Etudes Anthropometriques sur les Voleuses et Prostitutes.

level of the female thief exceeds that of the prostitute. She has more self-respect, more intelligence, is more energetic and struggles better in the contest for existence. She is less lazy and more given to work which she does not fear. However incorrigible be the professional thief and however numerous her crimes,she cannot commit and repeat them every hour of the day, it being assumed that these and prostitution are equally vicious unities. The thief sins but by intervals while the prostitute in a house sells her body without relaxation, accepts her abject trade agreeably and does not want to change it. Laziness and absence of moral sense are the principal traits characteristic of the prostitute. The thief generally gives evidence of a more stable and serious disposition than the prostitute. She is less given to alcoholic abuse and in confinement can be more readily induced to work."

The confidence operator type of the prostitute is excellently illustrated, as Harriet Alexander* has pointed out, in Alphonsine Plessis idealized by Alexandre Dumas in *Camille.* Her paternal grandmother who was half prostitute, half beggar, gave birth to a son by a country priest. This son was a kind of country Don Juan, a peddler by trade. The maternal grandmother was a nymphomaniac whose son married a woman of loose morals by whom a daughter was born. This daughter married the peddler and their child was Camille. The idealized Camille declines an opportunity for a higher life offered her by a Duke whose daughter she resembles. She prefers the glitter, glare and boisterousness of her life to the settled conditions of normal civilized existence. The religiosity which she displayed is very frequent among female criminals and prostitutes according to Lombroso, Marro, Ferrero, and Havelock Ellis. This results from, as Spurgeon points out in one of his sermons, that strange yet natural law by which excessive religion is next door to sensuality. Emotional religious appeals as the Rev. J. M. Wilson‡ shows, are far from rooting out sensuality and even stimulate increased licentiousness. In the

***Medical Standard* Vol. XIV P. 43.

‡*Journal of Education*, 1881.

case of Camille, as in others, this religiosity led to the term *Lorette* being applied to the French *demi-monde* during the second empire. This title was given because their favorite church was that of the Virgin of Loretto. The same phenomena have been noticed among female criminals. The criminal, as Havelock Ellis remarks, when not superstitiously devout is usually stupidly or brutally indifferent. The phenomena of religiosity as might be expected is peculiarly frequent among sexual offenders. Sixty-one per cent of these are frequenters of church. Among 200 Italian murderers Ferri did not find one who was irreligious. When a woman who had strangled and dismembered a child in order to spite its relations heard her sentence of death pronounced, she turned to her lawyers and said: "Death is nothing. It is the salvation of the soul that is everything. When that is safe, the rest is of no account."

The apparent increase of crimes among women is not due solely to the influence of education or of the removal of seclusion but to the fact that criminal woman who, formerly secluded, induced man to commit crime for her, is now, under improved social conditions, compelled to commit her own crimes. This is especially the case, as there is less chance for detection than there was under conditions where as in Spain and elsewhere women are closely watched. Careful study of sex in crime indicates that the crime rate of anti-social criminality falls among men as it rises among women. With the growing enfranchisement of women there is also a greater tendency to hold them to stricter accountability and hence a greater tendency to increase in the registration of criminality. With the growth of sentiment against drunkenness many criminals are now made by law from offenders formerly ignored. Unfortunately also early statistics are very defective, since a great many sentences were suspended if criminals, especially women, consented to go beyond the seas. In dealing with the influences of education it must be remembered that many moral defectives are now able to obtain education which formerly was inaccessible to them. Education has not increased crime, but more criminals are educated.

For anthropometric purposes I began a series of investigations along the lines already indicated at the State Home for Female Juvenile Offenders at Geneva, Illinois. For the data here employed I am deeply indebted to Mrs. Ophelia Amigh, its efficient matron, and to Drs. H. L. LaBaum, Ava Michener and Mary C. Hollister.

The mental side is the first that attracts attention. There was but one demonstrable case of insanity. This was of the periodic type and was not benefited by hospital treatment. The insane source of the alleged criminality was discovered in the State Home, not by the parents or court officials who sent the subject there.

No demonstrable motor expressions of epilepsy have been observed, albeit some of the mental phenomena manifested, decidedly suggest epilepsy. The craving for excitement, for intoxication, for uproar, which is such a characteristic of primitive man and of frontiersmen, finds among criminals its chief satisfaction outside the prison, in the love of orgy which, according to Ellis, is confined in its extreme forms to the criminal and his intimate ally, the prostitute. Ellis here puts things too strongly since this condition, an expression of unstable equilibrium, crops up very frequently under conditions of strain among people who certainly do not belong to the criminal class. Indeed in many natures strain from conventionality produces the effect of the prison on criminals. In Germany periodic explosions in prisons are known as *Zuchthaus-knall* and have been described by Delbruck and Krafft-Ebing. In the English-speaking countries they are comparatively common and were described by Eliza Farnham* in Sing Sing prison over half a century ago. Sometimes the prisoners know when the fit is coming on and will ask to be locked in refractory wards themselves. The younger they are the worse they behave. Some years ago in the Illinois State Home then under charge of a Christian Scientist, an insurrection drove nearly all the officers from the place. Nerve storms are still frequent in this institution. In inmates of a low order of intelligence personal violence rather than

***American Journal of Insanity*, April, 1846.

simple destructiveness often occurs. These outbreaks have a tendency to spread because they are often stirred up for mischievousness.

Like Dr. Pauline Tarnowsky, Drs. L. H. LaBaum and Ava Michener have found that the onset of puberty, so far as the menses are concerned, displays many irregularities. The usual influence of institutionalism on arrest and irregularity of menstruation has here to be taken into account. Allowing for this, menstruation often ceases for a month or two or a year after it is once established. This was long ago noted by Du Chatelet* among the same class in Paris sent to the reformatory convents. The girls thus affected are in perfect health and show no ill effect from the cessation. The menstrual flow commences again without the aid of medicine. Some of the girls who have been in the Home since the age of 10 or 11 years have never menstruated, yet are robust, healthy girls, nearing the time for their final dismissal (the age of 18) from the Home.

It is a noteworthy fact that among many primitive races menstruation displays many irregularities.† Cook, the ethnologist of the Peary expedition, found that menstruation among the Eskimo women only began after the age of 19 and was usually suppressed during the winter months. Lapland and Greenland women usually menstruate every three months or but two or three times a year. On the Faroe Islands menstruation is frequently absent. Among the Samoyds menstruation is so slight that its existence has been denied. Among the Guianas of Paraguay menstruation is not only slight in amount but the periods are separated by long intervals. According to A. B. Holder, the full-blooded Indians of Montana do not menstruate as freely as white women.‡ Among the naked women of Tierra del Fuego there are no physical signs of the menses. From time to time, cases appear in American medical literature in which healthy women resemble the Eskimo and Fuegians in this particular.

**American Journal of Obstetrics*, 1892.
†*La Prostitution.*
‡*Psychology of Sex*, vol. II, Ellis.

Of the inmates of the institution examined, one began menstruating at 9, two at 10, two at 11, twelve at 12, thirty at 13, twenty-eight at 14, fifteen at 15, and eight at 16. These figures differ from those given by Pauline Tarnowsky. Two per cent began at 11, fourteen per cent at 12, fourteen and sixteen hundredths per cent at 13, fifteen and thirty-three hundredths per cent at 14, nineteen and thirty-three hundredths per cent at 15, twenty and sixty-six hundredths per cent at 16, eight and sixty-six hundredths per cent at 17, three and thirty-three hundredths per cent at 18, and two per cent at 19. Forty per cent of Tarnowski's prostitutes had begun menstruation between 11 and 15. Ninety per cent of the Geneva juvenile offenders had begun menstruation between the same periods.

There are therefore striking differences as to the late and early onset of menstruation between the Chicago and the St. Petersburg cases. Neither climate nor early sexual knowledge will account for these differences. It is true that Joubert* of Calcutta claims that early menstruation in the Hindoos is due to precocious sexual knowledge and early exposure to sexual excitement. From the early marriages of the Hindoos and the phallic element of their worship these conditions are obviously present. To them many of the Indian tribes which menstruate late ascribe the onset of menstruation. Such conditions are present in all large cities in slum districts where the population is originally of rural origin. In all probability atavistic peculiarities when not due to sexual precocity, the product of arrest at the senile or simian epoch of intra-uterine existence, are of influence here.

The influence of irregular sexual life possibly dependent on arrest at the indifferent sex period of intra-uterine life, must be taken into account, since as Dr. Michener remarks, three-fourths of the inmates of the State Home are addicted to sexual perversities among themselves indicating the existence of sexual perversion.

The genitals in eighty-three cases were normal; in eleven cases were excessively developed and in seven were

**British Medical Journal*, May 15, 1895.

arrested in development. There was one case of markedly deformed labia. A large proportion of the inmates had had early sexual relations, as determined by confession or hymenal conditions. The condition of the hymen and vagina in many of these girls with their explanation of the same justifies the opinion that practices described by W. T. Gibb* as present in New York are to be found in Chicago, albeit imported from Europe. Gibb cites cases where adult females, with designs to enlarge a child's genital organs so as to fit her for coitus, introduce the finger, candles, round sticks or stones into the child's vagina. In the observance of ancient phallic worship, stones shaped like the adult penis were forced into the vaginæ of children to prepare them for sexual intercourse. The practice of thus injuring children is common in Europe. Mothers themselves frequently inflict these injuries upon their own children for the purpose of selling them into prostitution, very young children being particularly desired for sexual intercourse, especially by old men. Casper† cites the case of a 10-year-old German girl whose vagina had been dilated in this way by her mother, who first used her fingers as dilators, and then forced a long smooth stone into the vagina. Ogston† refers to this iniquitous practice in Edinburgh and describes the peculiar funnel-like dilatation, it is also described by Tardieu‡ and others.

There were nine cases of syphilis and fifty-four of gonorrhœa which, considering the class is not a very high percentage. The percentage of accidentally acquired venereal disease could not be determined. It is probable that this is large since cleanliness is not as predominant among these girls as it is with open prostitutes. Clandestine prostitution for this reason is the great source of venereal disease.

Among the inmates nearly all types of criminals occur. There are, to adopt my classification elsewhere given, congenital criminals, accidental criminals, periodical crimi-

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*McLane Hamilton's *Legal Medicine*, Vol. I, p. 650.

†*Forensic Medicine.*

‡*Medical Jurisprudence.*

‡*Attentats aux Moeurs.*

nals, criminals on occasion and law made criminals. As elsewhere the weak-willed criminals predominate. There is also a by no means small number whom external accident has placed in the institution. Home environment as already pointed out has been a potent factor in this particular.

The number examined was 111, of whom seventeen were Americans, twenty-eight Germans, twelve negroes, eighteen Irish, three Jews, four Polish, nine English, three French, one Italian, one Swedish, three Bohemians, seven Scotch, four Norwegians and one Swiss. As parental nationality or race was not obtainable to the extent required these figures cannot be properly analyzed. The Jewish percentage is much greater than is usually claimed but does not much exceed the percentage of other degenerative states among this race, in whom intermarriage has added to the effects of hereditary defect. The percentage of hebephrenia and epilepsy among Jewish boys is as great as this. In all probability many Americans, English and Scotch should be placed among the Irish as of Irish parentage. While environment explains the extremely low crime and prostitution rate of Ireland, still Ireland for centuries has shipped her degenerates to the British colonies, to America, to England and to Scotland. The Irish rate is lower proportionately than the American rate of Irish defectives. The French and French Canadian rate is high, but no higher than the general rate of defectives among this class. The negro rate is by far the highest with perhaps the exception of the Swiss. This is in accord with the growth of degeneracy among urban negroes. City life attracts the most active degenerates from rural districts. Since the war there has been marked increase of degeneracy among the negroes. Another element however, should be taken into consideration; the negro is now more judged by white standards and this produces an undue proportion of negro criminals, hysterics, and lunatics. The usual influence of urban conditions on rural defectives is here evident. The thrifty republic Switzerland has not abandoned its old-time policy of shipping defectives elsewhere. It furnishes likewise an undue proportion of the jobbing "German"

politicians of Chicago. The Scotch and English proportion indicate the effects inebriety may produce on the offspring. To a certain degree this is also illustrated among the Irish. The Bohemian and Polish contingent is large, but no greater than the proportion of degenerates found among the defectives shipped from those countries for labor purposes. The Norwegian proportion is high but no higher than the proportion of hereditary defectives from that country. Among Norway's rural population,monotony, isolation, defective diet and bad sanitary conveniences have produced the same effect on farmers' wives that Awl, Brigham, Ray, Patterson and other American alienists found to be so frequently produced on the farmers' wives of New England, of New York, Pennsylvania, of Ohio and Iowa, during the first four decades of the last century. The same is true to a lesser degree of Sweden. Maritime nations of necessity, moreover, have an undue proportion of juvenile criminals which result from the corruption occurring among sailors through their contact with primitive vices and with vices produced by enforced celibacy.

(*To be Continued*).

THE

ALIENIST AND NEUROLOGIST.

VOL. XXIII. ST. LOUIS, APRIL, 1902. No. 2.

JUVENILE FEMALE DELINQUENTS.*

By EUGENE S. TALBOT, M. D., D. D. S.,

CHICAGO.

CONSIDERING the class and the environment of the subjects, the number of cases in which the hymen persisted seems large;in twenty-one instances a hymen was present of size and character that at first sight seemed to indicate virginity. This however would be an erroneous presumption, since in by no means a small number of cases does the hymen persist after repeated coition. The hymen has been divided into several types by E. S. McKee† of Cincinnati, whose classification is a fairly serviceable one. The first type is the hymen semi-lunaris or so-called normal hymen which is most frequent. The second type is the hymen *circularis* with small central opening. The third type is the hymen *cribiformis* which is sieve-like, containing many holes like a water pot. The fourth type is the hymen *fimbriatus* which resembles the fringe-like appendages of the *ostium abdominale* of the fallopian tube. This form is the most important from a forensic point of view since it may be taken for a hymen which has been torn. The fifth type is the imperforate hymen which is a frequent cause for surgical interference because of resultant menstrual retention. It may obstruct penetration of the male organ. It is far from uncommon in primitive races and in some instances leads to special ceremonies of a phallic religious type precedent to marital coitus. It is not unfrequently so yielding to pressure as to remain despite repeated coitus.

*Continued from ALIENIST AND NEUROLOGIST, January, 1902.

†*Medical Standard*, vol. v.

This type modified by a small opening was rather frequent. The sixth type is that in which the opening of the hymen is divided by a perpendicular bridge into two parts. This strip of tissue passes from the concave border of the hymen to the *meatus urinarius*. In the seventh type there is an upper or anterior and a lower or posterior opening with simply a band lying transversely across the vagina. A second hymen is sometimes found above the first. The eighth type is the horseshoe hymen and the ninth type the bilobate hymen. These various types occur with greater frequency among the defective classes than does the first or so called normal type.

There were eight cases of enlarged clitoris but no special relation was determined between these and sexual perversities, albeit instances of this kind occurred. The association of sexual perversities with an enlarged clitoris, is, as Havelock Ellis* points out, far from being as frequent as was assumed by early writers. Sexual perversion, as J. G. Kiernan‡ has pointed out may, however, result in psychic pseudo-hermaphrodism, from experiments by females with the enlarged clitoris of the pseudo-hermaphroditic female or by males with the cleft of the pseudo-hermaphroditic male. Some of the perversities observed are sexual organ fetichism of the obsession type rather than true inversion. Many perversities were indecent plays of the type found by Niceforo among Italian shop and factory girls which have a superficial homosexual appearance.

Such plays, as Havelock Ellis remarks, cannot be considered eminently innocent or wholesome but on the other hand they are not radically morbid or vicious. They are strictly or even consciously play; they are dominated by the thought that the true sexual ideal is normal relationship with a man and they would certainly disappear in the presence of a man. These "plays," however, may lead to inversion later, in the prostitute type which certain juvenile female delinquents tend to become. As the female thief is nearer the normal there is less of this tendency in her.

*Psychology of Sex: Sexual Inversion.
‡ALIENIST AND NEUROLOGIST, 1891.

There were eighty cases of refractive error examined. These were selected for examination on account of headache, inability to see the blackboard in school, blurring and pain in the eyes for near work. Forty-nine had compound hypermetropic astigmatism. Twenty had hypermetropia. Seven had simple hypermetropic astigmatism. Three had myopia and one compound myopic astigmatism. Eleven were refracted without a mydriatic and sixty-nine with a mydriatic. These results of Mary C. Hollister would need to be tested by the comparative frequency of the conditions among the people to which the girls examined belonged. It must be also remembered that in the home the subjects would be exposed to conditions determining eye strain which did not exist in their ordinary environment. The apparent increase of eye defect as shown in the use of glasses is rather due to the increasing strain of environment than any increase in eye defect. The alleged increase of eye defect from rise in culture is an expression of environmental change involving strain. Here as elsewhere civilization does not so often produce defect as it demonstrates its existence. Primitive man shows certain mental and physical defects on sudden exposure to civilization not because civilization causes degeneracy but because toward civilization he displays the qualities of a degenerate born in civilization. Rise in evolution is always accompanied by a lesser expenditure of force to accomplish a given result as Herbert Spencer long ago pointed out. This lesser expenditure of force is secured by an increasing complexity of checks. These checks constitute mental and physical self-control. The fittest to survive is determined by the environment under which the survival is to occur. The "over man" of Nietzsche is the fittest under primitive conditions to survive but the very qualities which secure this survival are those which would destroy him under conditions where the "secondary ego" is better developed. The germ of this "secondary ego" among the social animals leads to procedures by the herd which resemble those that society adopts toward mental and moral defectives. Some criminals, as Tarde has remarked, would have been the ornament and

moral aristocracy of a tribe of Red Indians. "The psychic characteristics of the criminal" as Havelock Ellis* remarks "constantly reproduce the feature of savage character; want of forethought, inaptitude for sustained labor, love of orgy, etc. These should not be attributed to the direct influence of atavism. When an original vice of organic constitution has thrown an individual into a more primitive and remote stratum of society the influence of environment will itself simulate the effects of atavism and exaggerate its significance. If the organic impulses of a man's constitution have led him to throw in his lot with brigands, he will not fail to live as a brigand lives, that is, as a barbarian lives. This is not atavism though it may be the outcome of atavism or arrest of development."

The eye sight of criminals was found by Bono to be superior to the normal. He examined one hundred and ninety juvenile delinquents in comparison with one hundred youths of similar age in an agricultural institute. The visual acuity of forty-nine per cent of the criminals was superior to 1.5 Snellen. Only thirty-one per cent of the honest youths had an equal acuteness These results contrast with those found by Mary C. Hollister. Only ten of eighty-three cases examined for distinct vision has a visual acuity of one. Her results were as follows: without glasses of the eighty refracted eleven had vision equal one-tenth. Seven had vision equal one-fifth. Seven had vision equal one-fourth. Ten had vision equal one-third. Forty-five had vision equal one-half to two-thirds. Eighty-three cases were not refracted, of these two had vision equal one-fifth, two had vision equal to one-fourth, nine had vision equal to one-third, thirty-four had vision equal to one-half, twenty-six had vision equal to two-thirds, and ten had vision equal to one. These results however do not markedly differ from those of Case* in the instance of the inmates of the Elmira Reformatory. The greater number of diseases of the visual apparatus in the Reformatory inmates can, Case remarks, be traced to accidents and the habits

*The Criminal.

*New York State Reformatory Year Book, 1895.

incident to early life and the general degeneracy of the individual from inherited and acquired syphilis, alcoholism, dissipation and vice, tobacco privation, malnutrition, etc. As errors of refraction depend largely upon a disproportionate structure of the eye, a want of harmonious relation of the anatomy of the eye and its refractive media, refractive errors must occur frequently in such individuals in whom lack of symmetry is so common a characteristic. The expression of many of the eyes is peculiar. As the cranial and facial measurements are disproportionate in many cases, it must follow that the orbits are likewise. Hence these may be either too narrow or too broad inter-pupillary distances. It has happened to be the latter in Case's experience at the Reformatory. He has records of several instances in which it was three inches, whereas the average is about 2.3 inches among adults outside. As might be expected from the anomalous physical development an extremely high degree of refractive error exists. Contrary to the generally accepted view of ophthalmologists myopia and myopic astigmatism are the most frequent focal errors found.‡ These forms of refractive error are claimed to be the result of civilization and education of high pressure and competitive examinations in school and prolonged application of the individual to close work and study. The class of men found in the Elmira Reformatory should practically be exempt from near-sightedness if this view be correct. But the opposite are the exact conditions found. There is little doubt, but in many instances there is an inherited tendency to near-sightedness transmitted through many generations and that unhygienic environment and general deterioration of these subjects weakens the coats of the eye and precipitates these conditions. The other focal errors do not differ essentially from those encountered in general practice save in the prevalence of high degrees of the same. Disturbance of the equilibrium of the exterior ocular muscles in a tendency of the eye to turn in the abnormal directions, so-called dynamic squint were not noticed. They are not so common as in general society. Sequelæ of cor-

‡Dr. Hollister's results do not agree with these.

neal lesions are of common occurrence. Opacities both localized and diffused with interstitial deposits of corneal layers are often seen and evidences former traumatism. In some cases they indicate a previous specific trouble. Disease of the iris, crystalline lens and deeper structures of the eyes are frequently seen but are not characterized by anything peculiar to these individuals. In reviewing what has been said the conclusion is entertained that the physical make-up of the adolescent criminals is reflected as well in his visual organs as in other proportions of the body and the predisposition to eye trouble is inaugurated at birth. The environment, personal habits and mode of living only serve to act as exciting causes upon an already predisposed organism.

The ear in criminals has received much attention. The external ear, as Ellis remarks, is an organ which, though it still seems to be not wholly without use is undergoing retrogressive dissolution. It is very sensitive to the slightest nervous disturbance and such nervous disturbances occur frequently in persons who must be regarded as fairly normal. But they occur much more frequently as a rule among the abnormal classes of society. Thus Gradenigo (a very competent observer having a full knowledge of the fallacies involved in over hasty conclusions) examined several thousand persons of both sexes both among the ordinary population and among insane and criminal men and women. He found that the percentage of regular ears among men of the ordinary population was fifty-three; among women sixty-six; among insane men, thirty-six; among insane women, forty-six; among criminal men, twenty-eight; among criminal women, sixty-four. Thus while women always possess more regular ears than men, both criminals and insane show a smaller proportion of regular ears than the ordinary population and criminals come out below the insane. Gradenigo also pointed out the important fact (not always sufficiently emphasized) that the ear anomalies of the criminal and insane are not only greater in number but of greater gravity than those found in the ordinary population. Thus while no one would follow the scornful advice of a foolish critic of criminal anthropology, to call a man a criminal because of the shape of his ears, yet the shape of the ear still has real significance. The conditions found in the Geneva Home are best given in the following tables:

TABLE I.

AURICLE.

Length.	1⅞	2	2⅛	2¼	2⅜	2½	2¾	3
	1	11	12	56	17	4		

Width.	¾	1	1⅛	1⅜	1¼	1½	1¾
		11	48	1	48		2

HELIX

Develop-ment. Arrested..	Develop-ment. Medium ..	Develop-ment. Excessive	Form Folded......	Form Open........	Root Abnormal	Root Normal....
80	1	30	37	74	64	47

ANTI HELIX.

Develop-ment. Arrested..	Develop-ment. Medium ..	Develop-ment. Excessive
59	1	51

TUBERLES OF DARWIN.

Upper 3rd. Right	Upper 3rd. Left..........	Middle 3rd. Right	Middle 3rd. Left..........	None........
33	32	42	47	49

TABLE II.

LOBULE.

Attachment. Close........	Attachment. Medium......	Attachment. Separate....	Shape. Broad	Shape. Long	Shape. Narrow .. .	Development. Arrested ...	Development. Medium.....	Development. Excessive .
86	24	1	81		30	39	6	69

TRAGUS.

Development. Arrested ...	Development. Medium	Development. Excessive ..
73	22	16

ANTI TRAGUS.

Development. Arrested	Development. Medium......	Development. Excessive..
80	10	21

CONCHA.

Large........	Small	Deformed ..
25	11	75

ANGLE.

Right..........	45°	Close ... .
	11	100

RELATION.

Right Higher....	Left Higher....	Normal.......
1	3	107

These results indicate a greater frequency in ear abnormalities among women than the percentages of Gradenigo, but are in accord with the results of examinations made by Harriet Alexander and myself in the Chicago Bridewell.*

The occiput in forty-two was arrested in development; in twenty-six there was excessive development; the rest were of medium development. The bregma was high in 109 and low in two. The forehead was high in sixty-three; low in thirty-five and receding in thirteen. A kephalonoid type of skull was rather frequent. The jaws were normal in forty-five; V-shaped in thirty-one; partial V-shaped in sixteen; saddle-shaped in four; partial saddle in ten and semi-saddle in four. The alveolar process was normal in 107 and hypertrophied in four. The teeth were regular in seventy-four cases and irregular in thirty-seven. Tubercles were present in fifty-five cases.

A significant fact in connection with criminality was the maldevelopment of the thyroid gland. This was present in sixty-four cases; of these forty had an excessive development and twenty-four had arrested development of the gland. The influence of thyroid conditions on mentality has long been a matter of record. Its relationship however to moral imbecility has not been sufficiently studied. Ottolenghi however has called attention to anatomic relationships between thieves, sexual offenders and cretins.

According to Havelock Ellis a remarkable abundance of hair occurs among criminal women and is usually accompanied by a marked development of fine hair on the face and body. The hair on the head of seventy-four examined was thick; in thirty-seven it was thin. The hair was black in fourteen; brown in ninety-three, and blonde in four. The hair in ten non-negroes was curly. In eighty-nine cases inclusive of one Mongoloid Negro it was straight. The maternal ancestry was unknown.

**Medical Standard*, vol. xiii, 1893.

The cephalic index presented the variations shown in Table III:

TABLE III.

CEPHALIC INDEX.

Nationalities	Maximum.	Minimum.	Average.	Number.
American	86	72	75+	17
German	86	69	77+	28
Negro	73	65	71+	12
Irish	86	63	73+	18
Jew	83	72	77+	3
Polish	79	72	75+	4
Bohemian	72	72	72+	3
Norwegian	79	74	76+	4
Scotch	84	72	75+	7
French	83	67	73+	3
Swiss	82	82	82	1
Swedish	74	74	74	1
English	79	72	76	9
Italian	70	70	70	1

The variations in measurements out side of first permanent molars and second bicuspids are shown in Table IV:

TABLE IV.

MEASUREMENTS OUTSIDE. FIRST PER MOLARS AND SECOND BICUSPIDS.

Nationality	Greatest Width inside 1st Molars.	Least Width.	Average.	Greatest Width.	Least Width.	Average.
American	2.25	2	2.13+	2.12	1.75	1.83
German	2.25	2	2.18+	2.12	1.75	1.96+
Negro	2.25	2	2.16+	2.12	1.84	1.95
Irish	2.25	2	2.13+	2.12	1.75	1.89+
Jew	2.25	2.12	2.16+	2.	1 84	1.94+
Polish	2.25	2.	2.12	2.12	1.75	1.92+
Bohemian	2.50	2.	2.20	2.	1.84	1.89+
Norwegian	2.25	2.	2.06+	2.	1 84	1.88
Scotch	2.25	2.	2.08	2.	1.87	1.87
French	2.12	2.12	2.12	2.	1.75	1.91+
Swiss	2.	2.	2.	1.84	1.84	1.84
Swedish	2.12	2.12	2.12	2.	2.	2.
English	2.25	2.	2.16	2.	1.75	1.89+
Italian	2.	2.	2.	1.75	1.75	1.75

The variations in the height of the vault are shown in Table V:

TABLE V.

	HEIGHT OF VAULT.		
Nationality	Greatest Height.	Least Height.	Average.
American	.60	.50	.54+
German	.60	.50	.52+
Negro	.60	.50	.55+
Irish	.75	.50	.55+
Jew	.60	.50	.56+
Polish	.60	.50	.55
Bohemian	.60	.60	.60
Norwegian	.60	.50	.52+
Scotch	.60	.50	.54+
French	.50	.36	.45+
Swiss	.60	.60	.60
Swede	.60	.60	.60
English	.75	.50	.56+
Italian	·60	.60	.60

The variations in the facial angle are shown in Table VI.

TABLE VI.

FACIAL ANGLE.

Nationality	Greatest angle	Least angle	Average
American	80	64	73+
German	80	68	74+
Negro	78	66	71+
Irish	80	68	74+
Jew	77	72	74+
Polish	80	70	75
Bohemian	75	68	72
Norwegian	76	65	70+
Scotch	78	69	74+
French	78	70	75+
Swiss	78	78	78
Swede	78	78	78
English	80	65	70+
Italian	78	78	78

The average number of stigmata presented varied slightly. The average among the Americans, Germans, Irish, Jews, Norwegians and English was about the same, seventeen. The Negro, Polish and French average was about the same, sixteen. The Bohemians, Scotch, Swiss

and Swedes average the same, eighteen. The Italian average was highest, twenty, but this was found in the single case examined. Table VII gives the details.

TABLE VII.

No. Stigmata.	American	German	Negro	Irish	Jew	Polish	Bohemian	Norwegian	Scotch	French	Swiss	Swedish	English	Italian
13			2											
14	1	1	1	2						1				
15	1	2	1	3		1			1					
16	4	6	1	4	1	1				1			2	
17	1	6	4		1	1	1	2					3	
18	4	3	2	2			1	1	2		1	1	2	
19	2	6	1	2		1	1	1	4				1	
20	3	2		4	1					1			1	1
21	1	2												
22				1										
Average	17+	17+	16+	17+	17+	16+	18	17+	18	16+	18	18	17+	20

Table VIII gives the stature for reference:

TABLE VIII.

HEIGHT I.

		STANDING.			SITTING.		
Nationality....	No.	Greatest Height.	Least Height.	Average.	Greatest Height.	Least Height.	Average.
American	6	66	60	62+	34	30	31+
German	15	64	58	61	34	30	31+
Negro	5	66	56	60+	30	32	33
Irish	12	66	59	61+	33	29	31+
Jew	2	63	59	61	31	30	30+
Polish	2	65	60	62+	32	32	32
Bohemian	3	63	59	60+	33	29	31
Norwegian	1	63	63	63	32	32	32
Scotch	6	66	59	61	35	29	31+
French	2	65	62	63+	33	32	32+
Swiss	1	60	60	60	24	24	24
Swede	1	62	62	62	36	36	36
English	4	66	60	62+	32	30	31+
Italian	1	62	62	62	33	33	33

The variations are not specially significant as to departure from the norm.

Color blindness was not found in the 711 cases examined. Ottolenghi found but one case in 460 criminals tested

with Holmgren's wools. Holmgren on the other hand found that color blindness existed in 5.60 per cent. of 321 criminals, while among the ordinary population there was found scarcely 3.25 per cent. It is obvious that in the matter of color blindness racial influences are present. Among Nubians for example, color blindness is rare.

So far as observations were obtainable they tend to show that the juvenile female delinquent is markedly deficient in physical sensibility. This physical insensibility is, as Havelock Ellis remarks, associated with that moral anæsthesia which is the criminal's most fundamental psychic characteristic. The moral insensibility of the instinctive and habitual criminal, his lack of forethought, his absence of remorse and his cheerfulness were very early studied by Despine.

In a discussion of the question of race degeneracy some seven years ago* I pointed out that the criminal type did not even with a fostering environment always breed true to itself. The most frequently cited instance of alleged criminal heredity is the famous "Jukes" family. But of this family a little less than ten per cent became self-supporting, good citizens. The number of defective beings in the "Jukes" family did not considering the environment prophesy as much evil as the comparatively large number of normal beings augured good. Heredity, as J. G. Kiernan‡ points out, is a prophecy of what may be, not a destiny which must be. From the moment of conception the new being is subjected to varying environments and to the influence of atavisms which may work good or evil, irrespective of the impact of immediate heredity. This is well shown in the history of one case under observation in the Geneva home. The father came from a good family but was sent to prison for rape upon a daughter. One sister is a harlot and the mother is coarse. The girl who is 15 years of age left home on account of evil influences. She is not deeply immoral and is very bright. She has all the attributes of making her way in the world through good

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*Alienist and Neurologist, 1895.

‡*Medical News*, February 15, 1902.

channels and will undoubtedly realize her aspiration of becoming a nurse. She has already earned the confidence of her teachers and is a "trusty." Possessed of strong will-power it is doubtful if the immoral influences of her family will have any effects other than to increase her determination to lead an unstained life. In this case despite heredity and consequent environment, the moral anæsthesia so characteristic of the criminal and the lack of forethought do not appear. A mind like this needs but proper environment to become an excellent member of society. A similar case is that of the heroine of Besant's "Orange Girl" who despite an intense criminal heredity and bad early environment becomes almost a saint. Eugene Sue in his "Mysteries of Paris" depicts in the Martial family three members who rise against bad heredity and bad environment. One of them fights the theft and murder tendencies of his ancestors. Through his ethical tendencies, the plastic minds of a brother and sister are influenced for good. The father, mother, another sister and brother (savages born in the midst of civilization which has but sharpened their claws) die by the guillotine.

(*To be Continued*).

The Illinois Medical Bulletin

A MONTHLY JOURNAL OF MEDICINE AND SURGERY.

EDITED BY SETH SCOTT BISHOP, M. D., LL. D., 108 STATE ST., CHICAGO.
DR. FOSTER FRUTCHEY, BUSINESS MANAGER, - - 281 E. NORTH AVE.

VOL. 5 JANUARY, 1905. NO. 5

NEGRO ETHNOLOGY AND SOCIOLOGY.*

BY EUGENE S. TALBOT, M. S., D. D. S., M. D., LL. D., CHICAGO.
Professor of Stomatology in the Illinois Medical College.

Negro ethnology involves, first, his relation to other races, and second, his relation to both advance and retrogressive evolution or degeneracy. Racial ideas have changed considerably within the last two decades. It is now known that while there are language groups, language is no longer a test of nethic characteristics. There are Aryan-speaking peoples, but the Aryan race no longer exists as a standard. All races except some purely primitive ones without frequent intercommunication are impure in the old sense. The primitive elements are intermingled all over Europe with the high races that entered Europe from Africa and Asia, and with high and low Mongolic elements which came in with Attilla's Huns. The Magyar race derived from these is equal to any other races of Europe in science, art. literature and sociology, albeit its language is still Hunnic. The Magyars, however, display less of the Mongolic facial characteristics than many Latin, Slavonic and German speaking descendants of the Huns and Mongol elsewhere in Europe, or even the descendants of the Celtic-speaking Mongolic Firbolgs of Ireland, who are often taken as the race type. The true Irish type, the Celterieran, which came northward from Africa, presented the highest characteristics of what is called Aryan culture, whether found in the British Isles, in Scandinavia or North Germany, or in the Latin-speaking countries. The American Indians, equally mixed, are as even Professor Starr admitted in a discussion before the Academy four years ago, Caucasic, Mongolic, Negroid, and even more primitive races mingled in the Amerind. First the Sudanese are considered to be the true negro. The primeval home of the true negro was Africa. south of the Sahara. The present range is the primeval homeless Abyssinia, Calla, Somali and Masai Lands, Triploana, Mauritana and Egypt, several of the southern United States, West Indies, Guinea, parts of Brazil and Peru. The physical characteristics of this race are hair always black, rather short, crisp and frizzy, not woolly, differing from other human hair only in being flat in transverse section; color, very dark brown or chocolate and blackish, never quite black; skull, generally

*Read before Chicago Academy of Medicine, December 9, 1904.

dolichocephalic; jaws, prognathous; cheek bones rather small, moderately retreating, rarely prominent; nose very broad at the base, flat, small; eyes large, round, prominent, black, with yellowish cornea; stature above the average, five feet ten inches; lips tumid and everted; arms disproportionately long; legs slender, with small calves; feet broad, flat, with low instep and larkspur heel. The mental characters of the race are a sensuous, indolent, improvident temperament. The negro is fitful, passionate and cruel, though often affectionate and faithful. There is little sense of dignity and slight self-consciousness, hence easy acceptance of the yoke of slavery. There are general musical tendencies. Religion, as a rule, is anthropocentic fetichism with the fear of the unknown which invests all objects with human characteristics capriciously varying between the malign and benign. There is, therefore, a low grade of witchcraft, phallic worship, which requires human sacrifice and other means of placation of malign powers, first worshiped by primitive man. Culture is low. There is a cannibalism of low type. There is no science or letters. The arts and industries are mainly confined to agriculture, pottery, wood carving, weaving and metallurgy. There is no perceptible progress anywhere except under the influence of higher races.

Judging from this ethnic status of the true negro, no race of people has made such progress as the negro. What has taken the Anglo-

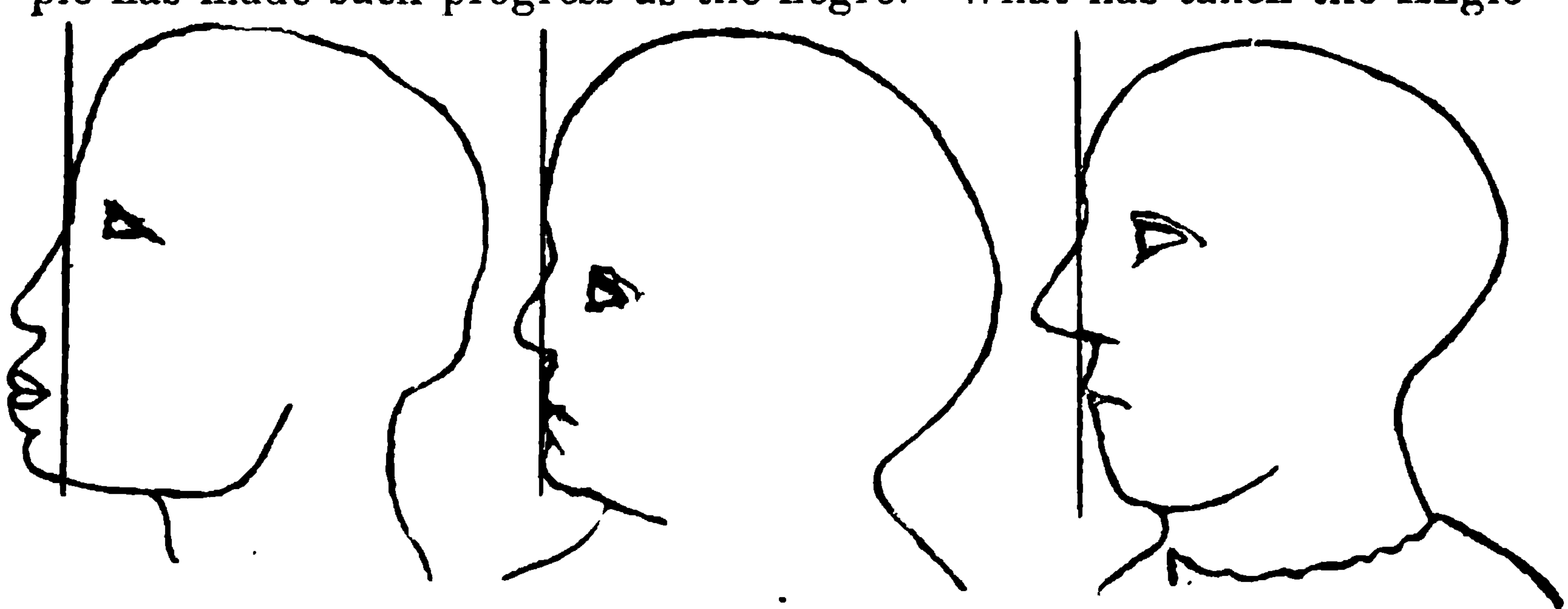

FIG. I. EVOLUTION OF THE FACE.

Saxon over one thousand years to accomplish, the negro has acquired in two hundred and fifty years, by breeding through other nationalities and by their environment. The importations of the negro to America placed him in a different mental atmosphere than that of Africa. Change of food without the necessity for procuring it, character of food, easily masticated under the law of economy of growth resultant from use and disuse caused rapid degeneration of the jaws and teeth. Intermixture with higher mentality, together with environment, caused the head to change from a dolichocephalic to a mesaticephalic type. In many cases a brachycephaly occurs. The forehead protrudes beyond the jaws instead of receding, thus giving the negro brain potentiality of development and mentality.

Marked changes, due to the influence of climate, soil, food and other factors of the immediate environment, were obvious to very early observers. According to Hippocrates, race is the daughter of climate. These seeming modifications have impressed skeptical biologists. Even Weissmann admits "the possibility is not to be rejected that influences continued for a long time, that is, generations, such as tem-

perature, climate, kind of nourishment, etc., which may affect the germ plasms as well as other parts of the organism, may produce a change in constitution of the germ plasm."

Some years ago I spent considerable time in research among the negroes in different parts of the country. To ascertain the evolution going on in the head and face, the facial angle of Camper and Cuvier was used, except that it was necessary to carry the perpendicular line down below the chin (Fig. 1). Starting on the basis that the negro was originally a dolichocephalic, prognathous individual, we obtain the following results today. Examination of 500 negroes in New Orleans showed that 97.5 per cent. protruded outside of the line, 2.5 per cent. on the line. These were the lowest class of the present day, men working on the wharves and railroads. An examination of 1,000 negroes in Philadelphia showed 83.57 per cent. outside the line, 15.97 per cent. on the line, and 1.13 per cent. inside. One thousand, examined in Chicago, showed 57.06 per cent. outside, 31.08 per cent on the line, 16 per cent. inside. One thousand, examined in Boston, showed 45.4 per cent. outside, 35.5 per cent. on the line, 15.1 per cent. inside the line. In those cases marked protrusion was only slight. The anterior development of the brain was, of course, in like proportion.

Ward has shown that absolute size of the lower jaw is greater in savages: "Of nine aborigines, including seven North American Indians, one African and one American negro, six Malays and five Australians, all with beautifully perfect teeth, the mean weight of the jaw was 102.4 grams. Of eighteen white males the mean weight of the jaw was only 83.4 grams. Yet the weight of the skull was nearly alike in both classes, being 690.9 grams for the aborigines as against 680.5 for the whites. The weight of the lower jaw compared with that of the cranium, or the cranio-mandibular index, as I have termed it, is 15.6 per cent. for aboriginal men as against 12.16 per cent. for white men. It is 46.2 per cent. for anthropoid apes, our nearest living relatives among the mammals.

Examination of the heads of eighteen negroes, taken at random, revealed that five had a cephalic index below seventy, six between seventy and eighty, and seven above eighty. These results tend to show that mesocephalic skull types are increasing in number among American negroes and that the jaws are gradually shortening. Dolichocephaly is decreasing. Upon examination of 2,000 negroes in Chicago, I found but six dolichocephaly. Even allowing for slight admixture of branchycephaly from the negro races themselves, it is obvious that changes in climate and admixture with the Indian and Caucasian races in America have completely changed the shape of the head as well as the physique of the negro.

The influence of admixture of race, climate, soil, food and a resultant struggle for existence has caused suicidal states among the negro not known among slaves previously to their state of bondage; on the other hand, there is probably no trade or profession in which negroes are not found. The change in shape of head from dolichocephalic to mesaticephalic, and modifications causing likewise change in brain development, enable him to forge ahead, should he so desire. However, there are puberty arrest tendencies predominating which prevent him from acquiring the same after adolescence.

The persistent prognathism of the negro arises from excessive development of the inferior maxilla. The rami and body of the lower jaw, also the muscles of mastication, are very large and massive compared with those of the white; upon the other hand, the superior maxilla is smaller and more delicate. The constant force of the larger lower jaw upon the upper causes the alveolar process to be carried forward and upward, thus producing the prognathism. American negroes today, especially those living in the Northern States, possess jaws not unlike those of the Caucasian races. The zygomatic arches are smaller, the muscles less dense and rigid, the lower jaws massive; and orthognathism in lieu of prognathism occurs to a certain extent. This is brought about by the arrest of development of the muscles and body of the lower jaw, due to change of climate and of soil and race admixture.

The arrest or degeneration of the jaws is quite marked so far as the teeth are concerned. In the lower negro types large teeth, with thirty-two in each set, find plenty of room, with little or no decay. In the higher negro types the arrest causes irregularities. Impacted third molars, and in some cases the germs of teeth, are not present. Decay is very common, showing that arrested or defective enamel is frequent.

Negro communities have not made much advance. On the contrary, there has been marked degeneracy in all the West India communities, particularly in San Domingo and Hayti, where the blacks, in a spirit of race hatred, have wiped out the Mulattoes. That these last might have guided these communities to a higher status is shown by the career of some of their descendants, like Dumas in France, and Puskin in Russia. Here, however, the later maternal ancestors have been Caucasian. That there has been marked degeneracy among the American negroes is best demonstrable in the census of 1880. This is degeneracy from parasitism. The Freedmen's Bureau was as responsible for this as the reservation system was responsible for the similar conditions obtaining among the Amerinds. Charity is always degenerative in its tendencies in any race. The results among the negroes, while somewhat exaggerated by temperament, are what might be expected anywhere. The increase of sadistic crimes is an expression of degeneracy rather than reversion. The sadism which strangles among Teutons, like Knapp of Ohio, is represented among the negroes, usually, by simple rape, which so agonizes the white victim as to give keen ecstacy to the sadist. Of late there has been shown a still more dangerous tendency to mutilation. Another degenerative factor is the failure of Southern communities to teach the negro the responsibilities of freedom. Chicken stealing and allied thefts, the heritage of slavery, have been regarded as offenses against the family. Repeated offenses of this kind should have been treated as constituting the habitual criminal and punished accordingly. Employment of convict labor in Southern communities has been another source of degeneracy, since it and the illegal peonage existing degrade labor and make it a stigma, not an honor. The natural result of these procedures has followed in the crimes of the degenerate, fostered by false views of the disgrace of labor.

Deformities of the Jaws Among European Degenerates.

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D., CHICAGO.

The Twelfth International Medical Congress, in Moscow, Russia, afforded a long-sought-for opportunity to visit nearly all the countries of Europe. I made special observations of the degenerates in each of the various institutions for the defective classes. The objective points of interest were the prisons, insane hospitals, schools of idiocy, foundlings' homes, etc. The features of the soldiers, police and cabmen, as well as of the citizens themselves, were incidentally noted for the purpose of comparison.

In a prison in Athens, containing four hundred and fifty-two convicts, not a single V-shaped or saddle arch was found, although slight irregularities of the teeth due to local causes were observed. Arrest of the lower jaw, however, was the rule, which, together with the recession of the forehead, gave to the individual an idiotic appearance. Irregularity in the relation of the upper jaw to the lower jaw, due to excessive arrest of development, was very common. The third molars, upper and lower, were present, but the vault was lower than the average.

In a Greek insane hospital (idiots are here confined with the insane) in Constantinople, of three hundred and thirty-two inmates, equally divided as to sex, only one case of V-shaped arch was noted; the vaults were low, the upper jaws large and full, but forty-eight per cent of the lower jaws were arrested; third molars normally developed.

In an Armenian insane hospital (idiots are here confined with the insane) in Constantinople, of two hundred and fifty inmates (one hundred and seventy-five males, seventy-five females) there was one partial V-shaped arch, the third molars normal and the lower jaw arrested in eighteen per cent. There were many mongoloid faces.

In the Vienna Insane Hospital, of three hundred and twenty-six insane and idiots there were four partial V-shaped and one saddle-shaped. The third molars were normally developed in three hundred and eleven cases.

In a prison in Moscow with two thousand convicts (two hundred and forty-seven of which were in the hospital) there were no

contracted jaws or irregularities of the teeth. The jaws were very large and the vaults low.

In the Moscow Reform School there were one hundred and twelve boys, ranging from ten to eighteen years. Three had partial V-shaped arches; no saddle-shaped arches. The jaws, as a rule, were large and broad, with low vaults.

In a Moscow insane asylum with four hundred patients, of which twelve were idiots, no contracted arches were observed. The jaws were large and broad, with low vaults.

In the Stockholm Insane Hospital, with two hundred and seventy patients, there were six V-shaped arches, twelve partial V-shaped, four semi-V-shaped, twenty-three saddle-shaped, four partial saddle-shaped arches, eleven excessively developed upper jaws, three excessively developed lower jaws, nine hypertrophy of the alveolar process, forty-two missing third molars, six missing laterals. Deformities of individual teeth numerous.

The School of Idiocy at Stockholm, with one hundred and twenty inmates (eighty boys, forty girls), gave the following results:

BOYS.

Normal jaws	14
V-shaped	12
Partial V-shaped	10
Semi-V-shaped	4
Saddle-shaped	8
Partial saddle	1
Semi-saddle	2
Hypertrophy of the alveolar process	32
Macrocephalic	12
Microcephalic	5

GIRLS.

Normal jaws	15
V-shaped	1
Partial V-shaped	5
Semi-V-shaped	5
Saddle-shaped	8
Semi-saddle	1
Hypertrophy of the alveolar process	14
Macrocephalic	6
Microcephalic	4

One boy, aged thirteen, who was able to take care of himself, had a head thirty-two inches in circumference, one of the largest on record.

The prison at Hamburg had eighteen hundred convicts. Large, well-developed jaws were the rule. Asymmetry in development, however, was frequently noticed, as well as other stigmata.

The School of Idiocy at Hamburg had six hundred children (three hundred and ninety-six boys, two hundred and four girls) and gave the following results:

BOYS.

Normal jaws	62
V-shaped	12
Partial V-shaped	16
Semi-V-shaped	8
Saddle	4
Partial saddle	3
Semi-saddle	2
Hypertrophy of the alveolar process	46
Macrocephalic	3
Microcephalic	4

GIRLS.

Normal jaws	28
V-shaped	4
Partial V-shaped	7
Semi-V-shaped	3
Saddle	1
Partial saddle	1
Semi-saddle	3
Hypertrophy of the alveolar process	25
Macrocephalic	5
Microcephalic	2

One boy of thirteen had excessive lower jaw, being one and a half inches beyond normal upper; a most remarkable case.

In the Insane Hospital and School of Idiocy at Amsterdam there were thirteen hundred and thirty insane and two hundred and fifty-five idiots. In the insane no contracted arches were found; vaults low, sixty-seven; hypertrophy of the alveolar process; no third molars missing.

IDIOTS.

Males	116
V-shaped	1
Partial V-shaped	3
Semi-V-shaped	1
Saddle-shaped	1
Females	139
V-shaped	1
Partial V-shaped	2
Hypertrophy of the alveolar process	19

The vaults low and jaws well developed.

The School of Idiots, Paris, six hundred and sixty-seven inmates (five hundred boys, one hundred and sixty-seven girls) gave the following results:

BOYS.

V-shaped	1
Partial V-shaped	40
Semi-V-shaped	2
Saddle	2
Partial saddle	1
Semi-saddle	4
Hypertrophy of the alveolar process	7

GIRLS.

V-shaped	1
Partial V-shaped	6
Semi-V-shaped	1
Saddle	8
Partial saddle	2
Semi-saddle	1
Hypertrophy of the alveolar process	4

The vaults were low.

In Paris the following prisons, namely, Ci-apes, Le Depot, Grande Roquette, Mazas, La Sante, St. Pelagie and St. Lazan, were visited. After examining two thousand six hundred convicts, no deformities of the jaws of special value were observed.

In England I examined the following public asylums: (1) Earlswood Asylum; (2) Darenth School for Children; (3) Darenth School for Adults, Hanwell Hospital for the Insane and the following private institutions: (4) Mrs. Langdon Down's, (5) Dr. Shuttleworth's, (6) Dr. Beach's.

A day was spent at the Criminal Insane Asylum, Broadmore. Fully one-half the inmates were so violent that the task was given up. Enough, however, was observed to warrant the opinion that fully eighty to eighty-five per cent had marked deformities of the jaws and teeth.

Hanwell Hospital for the Insane, Southall, had two thousand and eighty patients. These people were mostly of the dependent class, who became insane after maturity. The class of deformities which are under discussion were therefore not common. Hypertrophy of the alveolar process and excessive and arrested development of the jaws were, however, frequently noticed. Stigmata of degeneracy of head, face, eyes, ears, body, hands and feet were the rule.

Earlswood Feeble-minded Asylum, Red Hill, Surrey, con-

tained six hundred and seventy, of which four hundred were boys and two hundred and seventy girls.

BOYS.

Normal jaws	31
V-shaped	108
Partial V-shaped	69
Semi-V-shaped	11
Saddle	19
Partial saddle	27
Semi-saddle	13
Marked arrest of upper jaw	104
Marked protrusion of upper jaw	64
Marked protrusion of lower jaw	11
Marked arrest of lower jaw	306
Lateral incisors arrested	46
Lateral incisors lost	28
Third molars lost	180
Showed malnutrition of teeth	160

GIRLS.

Normal jaws	24
V-shaped	67
Partial V-shaped	86
Semi-V-shaped	24
Partial saddle	8
Semi-saddle	23
Cleft palate	1
Marked arrest of upper jaw	87
Marked protrusion of upper jaw	24
Marked protrusion of lower jaw	1
Marked arrest of lower jaw	237
Lateral incisors arrested	30
Lateral incisors lost	16
Third molars lost	85
Showed malnutrition of teeth	78

Darenth School for Feeble-minded, Dartford, Kent, had one thousand inmates (six hundred and forty boys, three hundred and sixty girls).

BOYS.

Normal jaws	150
V-shaped	143
Partial V-shaped	140
Semi-V-shaped	105
Saddle	35
Partial saddle	20
Semi-saddle	10
Marked arrest of upper jaw	450
Marked protrusion of upper jaw	150
Marked protrusion of lower jaw	23

Arrest of lower jaw	600
Lateral incisors arrested	68
Lateral incisors lost	42
Third molars lost	388
Hypertrophy of upper jaw	150

GIRLS.

Normal jaws	90
V-shaped	118
Partial V-shaped	80
Semi-V-shaped	65
Partial saddle	8
Semi-saddle	20
Marked arrest of upper jaw	310
Marked protrusion of upper jaw	90
Marked protrusion of lower jaw	9
Arrest of lower jaw	340
Lateral incisors arrested	32
Lateral incisors lost	19
Third molars lost	111
Hypertrophy of the upper jaw	90

Darenth School for Adults, Dartford, Kent, contained one thousand and fifty inmates (four hundred and fifty males, six hundred females).

MALES.

Normal jaws	60
V-shaped	105
Partial V-shaped	93
Semi-V-shaped	53
Saddle	31
Partial saddle	5
Marked arrest of upper jaw	295
Marked protrusion of upper jaw	162
Marked protrusion of lower jaw	8
Arrest of lower jaw	409
Lateral incisors arrested	48
Lateral incisors lost	37
Third molars lost	442
Hypertrophy of upper jaw	58

FEMALES.

Normal jaws	40
V-shaped	177
Partial V-shaped	121
Semi-V-shaped	79
Partial saddle	8
Semi-saddle	10
Marked arrest of upper jaw	436
Marked protrusion of upper jaw	209
Marked protrusion of lower jaw	17

Arrest of lower jaw	580
Lateral incisors arrested	72
Lateral incisors lost	62
Third molars lost	597
Hypertrophy of upper jaw	36

Of the children, five hundred and seventy-six showed malnutrition in utero; two hundred and eighty-two girls showed malnutrition in utero. Of the adults, three hundred and ninety-six males showed malnutrition in utero; five hundred and seventy-eight females showed malnutrition in utero.

Mrs. Langdon Down's School, Normansfield, Hamptonwick, contained one hundred and forty-seven inmates (ninety-seven boys, fifty girls).

BOYS.

Normal jaws	12
V-shaped	36
Partial V-shaped	20
Semi-V-shaped	15
Saddle	9
Partial saddle	13
Semi-saddle	28
Arrest of upper jaw	86
Third molar missing	92
Lateral incisors missing	16
Teeth showing arrest and grooves	46
Hypertrophy of the alveolar process	19

GIRLS.

Normal jaws	5
V-shaped	10
Partial V-shaped	9
Semi-V-shaped	12
Saddle	7
Partial saddle	1
Semi-saddle	16
Arrest of upper jaw	45
Third molars missing	47
Lateral incisors missing	8
Teeth showing arrest and grooves	21
Hypertrophy of the alveolar process	7

Of the twelve normal dental arches (males), seven were hypertrophied. Of the five normal dental arches (females), three were hypertrophied.

Dr. Shuttleworth's Private School, Richmond Hill, had twelve boys and girls. There was one normal jaw, but no laterals. There were two V-shaped, five partial V-shaped, one semi-V-shaped, two partial saddle and one semi-saddle-shaped jaw, four hypetrophy of

the alveolar process, nine had notched and pitted teeth, and all high vaults. These patients were too young to decide as to the number of third molars, but five had one or both laterals missing.

Dr. Fletcher Beach's Winchester House, Kingston Road, had thirteen patients. There were three V-shaped, eight partial V-shaped and one semi-V-shaped jaw, six hypertrophy of the alveolar process, eight had notched and pitted teeth, all high vaults. These patients were also too young to decide as to number of third molars. Four had one or both laterals missing.

These reports are tabulated in the order in which they were made. They show a gradual increase of degeneracy from the examinations made in Greece to those in England. It will also be noticed that the deformities of the jaws and teeth are more numerous among the better classes, such as are shown in the private institutions of Mrs. Langdon Down and Drs. Shuttleworth and Beach, than among those of the poorer classes in the public institutions of England.

From examinations previously made in Spain, Italy and Switzerland among the degenerate classes, a very small percentage of the deformities of the teeth and jaws was found. As compared with the American-born degenerate classes, the percentages are greater than those of the Latin races and the Slavs, Germans, Austrians, Danes and Dutch, but from twenty-five to thirty-five per cent less than the Swedes and English.

These observations show the operation of the law of economy of growth[1] whereby the struggle for existence between organs[2] centers in unbalanced organisms, with peculiar intensity between the later higher acquirements and the lower. This struggle most affects structure as transitory in evolution,[3] as the jaws and teeth. In races intellectually high the effect of the struggle on such structures will, as shown in the present statistics, be most marked in contrast with races lower in evolution, where jaws and teeth are less transitory in type.

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Reprint from the September issue of "THE ILLINOIS MEDICAL BULLETIN."

ANATOMIC CHANGES

IN THE

HEAD, FACE, JAWS AND TEETH

IN THE

EVOLUTION OF MAN

BY

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(Professor of Stomatology in the Illinois Medical College.)

READ BEFORE THE SECTION ON ANATOMY, PHYSIOLOGY, HISTOLOGY AND MICROSCOPY OF THE FOURTH INTERNATIONAL DENTAL CONGRESS AT ST. LOUIS, MO., AUGUST 1904.

THE ILLINOIS MEDICAL BULLETIN

PUBLISHED MONTHLY BY THE ILLINOIS MEDICAL COLLEGE, CHICAGO

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ANATOMIC CHANGES IN THE HEAD, FACE, JAWS AND TEETH IN THE EVOLUTION OF MAN.

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Read before the Section on Anatomy, Physiology, Histology and Microscopy of the Fourth International Dental Congress at St. Louis, Mo., August, 1904.[1]

In his evolution man has undergone many changes. Structures have been added, others lost. From Thales to Darwin, an attempt was made to discover the laws governing these changes. Empedocles, 495 B. C., outlined from his study the doctrines of evolution, involving therein the survival of the fittest. Aristotle, 384 B. C., viewed the relation of the structures and organs to each other from the standpoint of an hypothetic law of economy of growth, by which structures were sacrificed as entities to benefit the organization as a whole. Goethe, in 1809, and St. Hilaire, in 1818, still further cleared this law of obscurity.

Study of this revealed a struggle for existence between organs with interaction consequent on use and disuse of structures. Camper employed this law in his use of the ideal face of the Apollo Belvedere to illustrate the gradual retreat of the jaws from lower to higher types of face (Fig. I).

The facial angle of Camper, Cuvier, Cloquets, Jacquarts, the Munich-Frankfort Angle and that of Topinard involves merely the bones of the face, not the inferior maxilla. Most authors dealing with

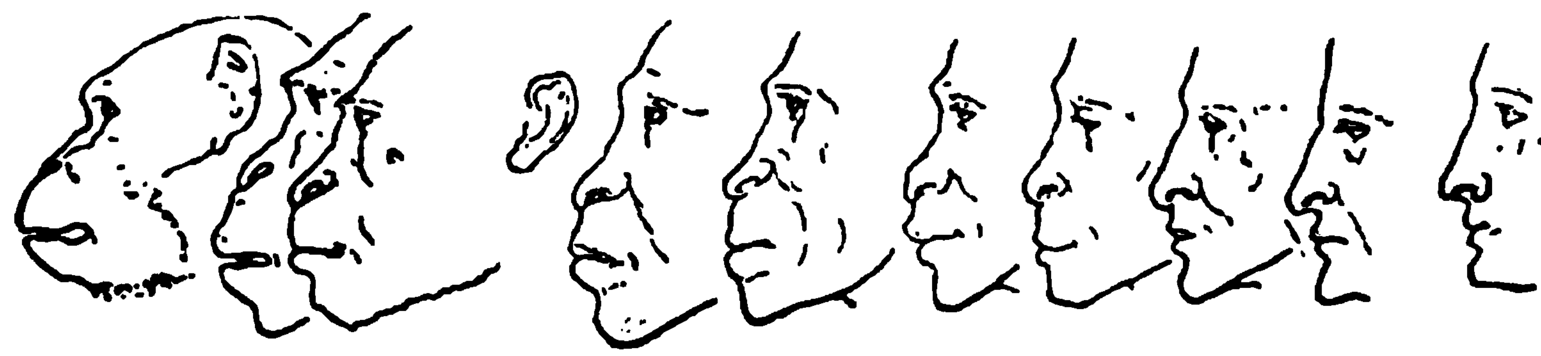

Fig. I.

prognathism and orthognathism include, therefore, merely the superior maxilla in the conception. Stomatologic specialists must include the inferior maxilla in the outline in order to determine what may or may not be required in improving the jaws and teeth. In my studies of the etiology of irregularities of the jaws and teeth, I have simply extended the facial line downward below the lower jaw (Fig. II). An imaginary perpendicular line dropped from the superciliary ridge below the lower jaw decides whether the jaws be prognathous or orthognathous.

The ideal face of Camper is a norm, which shows where anatomic progress ceases and pathologic begins. At one stage in the evolution of man, the eyes, face, nose, jaws and teeth were most essential in obtaining food for the nourishment of the body, and equally so in sexual selection. As man developed, owing to brain increase, he acquired the power of obtaining and digesting food with less expenditure of physical strength. Disuse of the jaws and teeth have become less a factor in food getting, hence atrophy.

The modern North American negro is an apt illustration. The evolution of the negro in North America has been most wonderful, mentally and physically. In 250 years he has developed from primitive conditions to equal in many cases the Caucasic. Typically the negro is long headed (dolichocephalic) with a face extending beyond the perpendicular line (prognathous). At the present time nearly 50 per cent. of negroes have faces on the line. Up to this period of facial atrophy, the cavities of the nose were large enough for the purpose of breathing, the jaws large enough for the teeth, the teeth rarely decayed, and interstitial gingivitis (owing to large, well developed alveolar processes) seldom occurred.

While healthy recession is still progressing under the law of economy of growth, the perpendicular line remains the dividing line between the normal and abnormal.

Associated with antero-posterior arrest, is lateral arrest of the face, which as a rule is about as great as the antero-posterior. In such cases protrusion (excessive development) of the nose and upper jaw often occurs. The lower is usually arrested. The contraction begins at the upper border of the nasal bones at their junc-

[1]Awarded the second prize.

tion with the frontal, extending downward to a point midway between the angle of the lower jaw and the symphysis of the chin. Some idea of this lateral contraction is given by Mummery's meas-

a

Fig. II

urements of ancient British and Roman skulls. These, from the outer surface of one first molar to the outer surface of the other (Fig. III), showed a width average of 2.50 inches. Measurements of Americans revealed an average of 2 to 2.19 inches in normal people, showing a difference in lateral development from those of Mummery of about .30 of an inch. The effect is to produce a narrow (hatchet) face.

In order of developmental atrophy of the face, the dividing line between the normal and abnormal in jaws and teeth would occur when the jaws from outside of the first molars measure from 2 to 2.20 inches, and the antero-posterior atrophy brings the face on or inside the perpendicular line. In a general way these two points are the lines of demarcation between normal and abnormal. Structures which degenerate for the benefit of the organism as a whole are transitory structures. At these two points, owing to arrests of development, the stigmata of degeneracy are most marked. At these points the normal ceases and the pathologic begins.

Fig. III

Conditions which modify healthy degeneracy or normal atavism are ordinary and socially consanguinous marriages, intermixture of races, climate, soil, food, etc. These, however, do not produce such marked arrests and excessive development as are caused by an unstable nervous system in the parent as well as in the child.

Even folklore, the science of primitive man, accepts direct relation of deformities in the child to the parent. Its taboos and charms are often attempts to regulate these.

With that stage of development of the religious sense marked by assigning malign occult powers to natural objects and forces, this view of degeneracy became systematized, and exposed weakly or deformed offspring, charged to evil powers, to death. This occult conception of degeneracy is even yet a part of American folklore. Against degenerate children charms are still used by the "witch-doctors" among the "Pennsylvania Dutch," who are on the level of culture of the early seventeenth century middle English, if not a little below it. The folklore of these, as embodied in Shakespeare, demonstrates, according to J. G. Kiernan[1] that, ere the seventeenth century, the fact that "mental and moral defect expressed itself in physical stigmata was recognized and even the term used." "It is an old prejudice, Thistleton Dyer remarks, not yet extinct, that those who are defective or deformed are marked by nature as prone to mischief."

In "A Midsummer Night's Dream" (v. 1) Oberon[2] wards off degeneracy from the issue of happy lovers by the charm—

> "And the blots of Nature's hand
> Shall not in their issue stand
> Never mole, hare-lip or scar,
> Nor mark prodigious, such as are
> Despised in nativity
> Shall not upon their children be."

"So many several ways are we plagued and published for our father's defaults," remarks old Burton[3], "in so much that, as Fernelius truly saith: 'It is the greatest part of our felicity to be well born, and it were happy for human kind if only such parents as are sound of body and mind should be suffered to marry.' An husbandman will sow none but the best and choicest seed upon his land, he will not rear a bull or horse except he be right shapen in all parts, or permit him to cover a cow or mare except he be well assured of his breed; we make choice of the best rams for our sheep, rear the neatest kine, and keep the best dogs. And how careful, then, should we be in begetting of our children. In former times some countries have been so chary in this behalf, so stern, that if a child were crooked or deformed in body or mind, they made him away; so did the Indians of old by the relation of Curtius and many other well-governed commonwealths, according to the discipline of those times. 'Henceforth in Scotland,' saith Hect Boethius, 'if any

[1] Alienist and Neurologist, 1895.
[2] Folklore of Shakespeare.

were visited with the falling sickness, madness, gout, leprosy or any such dangerous disease which was likely to be propagated from the father to the son, he was instantly gelded; a woman kept from all company of men, and, if by chance, having some such disease she were found to be with child, she with her brood were buried alive; and this was done for the common good, lest the whole nation should be injured or corrupted.' A severe doom, you will say, and ought not to be used among Christians, yet more to be looked into than it is. For now by our too much facility in this kind, in giving way for all to marry that will, too much liberty and indulgence in tolerating all sorts, there is a vast confusion of hereditary diseases, no family secure, no man almost free, from some grievous infirmity or other, when no choice is had, but still the eldest must marry, as so many stallions of the race; or if rich, be they fools or dizzards, lame or maimed, unable, intemperate, dissolute, exhaust through riot, as he said, they must be wise and able by inheritance. It comes to pass that our generation is corrupt, we have many weak persons both in body and mind, many feral diseases raging among us, crazed families, our fathers bad and we are like to be worse."

The unstable nervous system of the parent, which produces arrests and excessive development in the child, is often due to excesses involving toxic agents. These are divisible into those belonging to the condiments, medicines, foods and beverages, those arising from occupation and the auto-toxemias. Tobacco, alcohol, opium, tea, coffee, cocaine, as well as lead, mercury and brass produce toxic effects. Excesses in a social way, late hours, etc., may produce profound systemic nervous exhaustion with auto-toxemia in the ancestor and especially the ancestress, likely to be transmitted as degeneracy to the descendant.

The acute and chronic contagious and infectious diseases in the parent, especially the mother, necessarily exert the same toxic influences upon the fœtus, impoverishing it and checking healthy nutrition.

The factors producing degeneration in the child are due to a nervous exhaustion in the first generation which implies a practical degeneration in function, since tone is lost.

Every nerve cell has two functions, one connected with sensation and the other with growth. If the cell be tired by excessive work along the line of sensation or motion, the function as regards growth becomes later impaired, and it not only ceases to continue in strength but becomes self poisoned. Each of the organs (heart, liver, kidneys, etc.) has its own system of nerves (the sympathetic ganglia) which, while under control by the spinal cord and brain, act independently. If these nerves become tired the organ fails to perform its function, the general system becomes both poisoned and ill-fed, and nervous exhaustion results. In most cases, however, the brain and spinal cord are first exhausted. The nerves of the organs

[1] Anatomy of Melancholy, sixth edition, 1652, part 1.

are thus allowed too free play, and exhaust themselves later. This systematic exhaustion has local expression in the testicles in the male, in the womb and ovaries in the female. Through this the body is imperfectly supplied with natural tonics (antitoxins) formed by the structures, and the general nervous exhaustion becomes still more complete. All the organs of the body are weakened in their function. Practically the neurasthenic, in regard to his organs, has taken on a degenerative function albeit not degenerating in structure, since the restlessness of the organs is a return to the undue expenditure of force, which occurs in the lower animals in proportion as it is unchecked by a central nervous system. Through the influence of various exhausting agencies the spinal cord and the brain lose the gains of evolution, and the neurasthenic is no longer adjusted to environment. Since the reproductive organs suffer particularly, children born after the acquirement of nervous exhaustion, more or less checked in development as the influence of atavism is healthy or not, repeat degenerations in the structure of their organs, which in the parent were represented by neurasthenic disorders in function. As the ovaries of neurasthenic women are markedly affected by the nervous exhaustion, the offspring of these do not retain enough vigor to pass through the normal process of development.

On embryonic development maternal environment exercises an enormous influence in the direction of arrested or progressive development. Maternal shock produces arrests of development which are not photographic conditions, but survivals of embryonic states. While maternal impressions do have an effect, it is simply in conditions of arrest and not in photographic reproductions of the alleged cause of the impression.

In intra-uterine life, periods of stress occur around which, as Kiernan remarks, the disappearing and developing tendency of organs necessarily centers. At these periods certain functions and structures are to be lost by the disappearing and others gained by the developing organs; maternal shock checks proper progress at these periods.

When systemic balance, the result of evolution, is disturbed by change in environment, the organs, as has been shown experimentally by Jacques Loeb[1], do not pursue their usual growth. Such disturbances are peculiarly apt to occur during periods of stress because of the then varying relations of different organs.

Struggles for existence on the part of the different organs and systems of the body are, hence, most ardent during the periods of intra- and extra-uterine evolution and involution. During the first dentition, during the second dentition (often as late as the thirteenth year), during puberty and adolescence (fourteen to twenty-five), during the climacteric (forty to sixty) when uterine involution occurs in woman, and prostatic involution in man, and finally during senility (sixty and upwards), mental and physical defect may,

as I have elsewhere shown[2], be evinced in a congenital tendency, which has remained latent until the period of stress.

The first period of stress is most important so far as the head,

Fig. IV.

face, jaws and teeth are concerned. It is called the senile or simian pêriod (Fig. IV), and occurs at four and one-half months of fœtal life. The influence of neurasthenia in the parent may result in a bony arrest of development shown to occur in animals by Charrin and Gley, and in man by Coolidge. The facial bones, jaws and teeth are peculiarly liable to be thus affected. Though the effect of disease on the parent be but temporary, the child's development may be checked as to higher tendencies.

The factors entering into the struggle for existence most markedly involve the relations of the brain to the head and face. During intra-uterine life the face loses and the brain gains. During the first extra-uterine period of stress, between birth and three months, the brain is one-fifth the weight of the body, while in the adult it is but one-thirty-third. During the first six months the brain doubles in weight. The effect of stress during this period would, under the law of economy of growth, either be felt in diminution of the qual-

[1] Untersuch. zur Physiol. Morphologie.
[2] Degeneracy, Its Signs, Causes, and Results.

ity or quantity of the brain, or in the preservation of these at the expense of more transitory structures like the face, nose, jaws and teeth. This is well illustrated in the contrasted skulls (Fig. V).

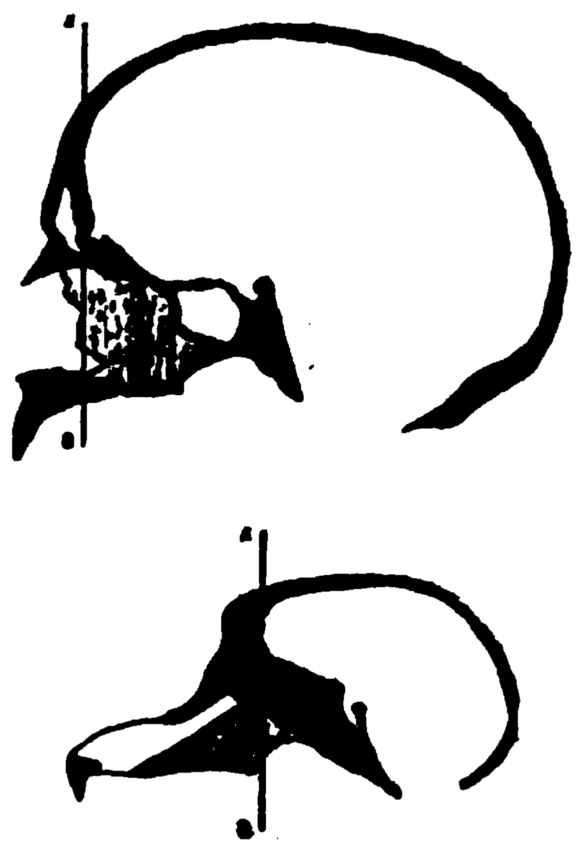

Fig. V.

After birth the face gains at the expense of the brain. The body and face, as a whole so gain on the growth of the brain that, as Havelock Ellis[1] remarks, further growth from the third year onward, though an absolutely necessary adaptation to environment, is, to some extent, growth in degeneration and senility. The loss of child potentialities is well shown in the accompanying illustration (Fig. VI), where the perfectly developed being, fulfilling the promise of the child, is contrasted with the man that the child actually becomes. Struggles for existence on the part of the different organs and systems of the body are most ardent during the periods of intra- and extra-uterine evolution and involution. At the periods of sex differentiation and at the simian or senile period (Fig. V) irregular balance given the struggle for existence leads to imperfect sex differentiation or premature senility. This last often produces irregular and incomplete ossification. Since, as Harriet Alexander[1] has shown, degeneracy is a process of evolution leading to alteration of form, because of cessation of inhibition in certain directions resultant on diminished work, it logically follows that, since diminished function precedes change of structure, increased function checks the change of structure in its bichemic stage. Nay, more structural elaboration due to gains from degeneracy may be retained while degenerate structures resume their higher functions. Hence a degenerate race may rank higher in evolution because of the beneficial variations due to degeneracy.

The structures of the face, as Minot has shown in man, are degenerate as viewed from the vertebrate type. They are structures

[1] Man and Woman.
[1] Medicine, 1896.

which quite early in evolution have been sacrificed to the gains of the central nervous system (Fig. VI). On them, therefore, do struggles for existence between organs leave decided marks. The jaws and face are less marked in type with rise in evolution.

The reverse phase of evolution, with which Camper did not deal, is that of which the present paper treats. This phase of evo-

Fig VI.

lution underlies all pathology of the face, as well as of the nose, jaws, alveolar process and teeth. The illustrations supplementing those of Camper portray this reverse phase where symmetry of the body as a whole is sacrificed to changes in the nose, jaws, alveolar processes and teeth. so as to preserve brain gains.

The following illustration (Fig. VII), taken from photographs of patients, accurately portrays arrests of the face for the benefit of

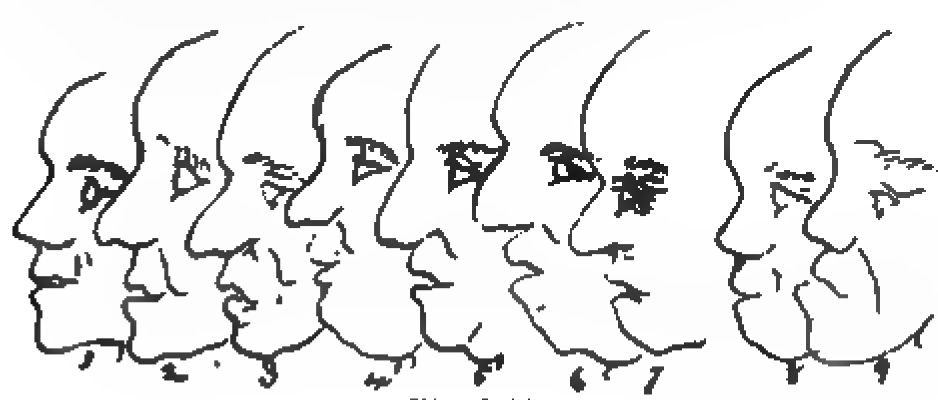

Fig VII

the brain. The gradual recession of the face and the forward development of the brain is a gradual continuation of Figure 1 in the line of evolution. From the relations of this face degeneration nearly all diseases of the nose, jaws, alveolar processes and teeth result. In many cases reverse evolution progresses still further till, owing to an unbalanced nervous system and movements of the lower jaw, atavism results. Illustrations 8 and 9, Figure VII, exhibit a greater exaggeration of the lower jaw, a return to the anthropoid and lower negro type.

Two facial types result from arrest of development. Figure VIII shows the arrest antero-posteriorly, Figure IX lateral arrest.

Fig VIII. Fig. IX.

All other forms are modifications of these two. They may become more intense or less marked.

Through phases of the evolution of man affected by an unstable nervous system, either in parent or child or both, arrests and excesses in development (degeneracies) may occur in the face, eyes, nose, jaws, alveolar processes and teeth and form the foundation of all pathology of these structures.

DEFORMITIES OF THE BONES OF THE FACE AND NOSE.

—BY—

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[Reprint From *The Laryngoscope*, St. Louis, May and June, 1902.]

DEFORMITIES OF THE BONES OF THE FACE AND NOSE.

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Much has been written upon the etiology of deformities of the nasal bones, especially deflection of the septum.

Numerous theories have been advanced to account for these deformities. Quelmalz and Schultz believed them due to the action of astringents drying up the membrane, causing it to contract and thus drawing the bone and cartilage down upon itself. In Morgagni's opinion they were due to excessive development of the vomer. Trendelenburg held that they were due to a crowding up of a high-arched palate since he found the two conditions frequently associated. Jarvis, after citing four cases in the same family, suggested the deformities were due to direct heredity. While the neurotic or degenerate states that underlie building up of the system may produce deflection, direct heredity here as elsewhere is rare, Schaus' and Welcker's investigations show that there is a faulty development of the facial skeleton. Bosworth[1] and others have charged septal deformities to traumatism. The clinical history of many cases affords, according to Bosworth, direct evidence of this and even in those cases in which the direct injury is not testified to, he thinks it is safe to say that an injury has occurred though this may have been so slight as not to have excited especial attention at the time of the occurrence. "Injury to the nose need not necessarily give rise to the immediate development of a notable deformity, as in fractures, but it may set up a low

1 Diseases of the Nose and Throat.

grade of morbid action, which, going on through a number of years, will finally develop a condition by which the normal function of the nose is seriously hampered." The point on which he lays especial emphasis is that deformity is primarily the result of traumatism and secondarily of a slow inflammatory process which results therefrom.

The theories most deserving attention are those of Bosworth and Trendelenburg. In an examination of 11,000 skulls, I found that owing to the fragility of the septum, the whole or anterior part of it was lost in many. But 7,600, therefore, had sufficient remaining to give an idea of its shape; 5,762 of this number showed marked deformities. Deflection of the septum did not extend uniformly throughout. On careful examination of these deformities, it was found that the septum could be divided into three parts, anterior, middle and posterior deflection. While traumatism occasionally may produce deflection in the anterior third of the nose, how it could produce deflection merely in the middle or posterior third of the septum is not very demonstrable.

That deformity and fracture of the septum may, however, be traced to traumatism, I am personally aware. In one case, when a boy of sixteen, I asserted my rights and received a blow upon the nose from my opponent which fractured the cartilage and made a lasting impression upon me. The theory that from 50 to 80 per cent or even 5 per cent of deformities of the septum are due to such injuries is demonstrably illogical. In the large number I examined, 2,684 possessed what appeared to be fracture. The vomer in many of these specimens commenced to deflect at its outer surface and gradually deepened until at about its middle or posterior two-thirds, it reached its deepest part and then gradually decreased in depth until the posterior attachment was reached. Its appearance was not unlike the sail of a ship. On the convex surface, in many cases, nature had thrown out provisional bone to support this curvature, which might be considered a break, but in most cases simply a bend. That a blow, whether slight or as powerful, could produce a fracture of the vomer, the greatest deformity of which is located from .75 to 2 inches inside the nose from the point of the nasal spine seems hardly probable. Anterior and posterior to this deflection, the vomer appeared in most cases to be nearly or quite normal. In nearly every case of fracture would involve only one-half of the vomer, the other simply bending; that

such a condition could be brought about by a blow is absurd. It seemed the greatest deformity was the thinnest part of the bone.

It would appear to be a very easy matter in the skull to decide whether a fracture had taken place before or after complete ossification by the character of the wound, thus approximating the date of the injury. That it was caused by a low form of inflammation set up as a result of a slight injury in utero or after birth does not seem rational since the inflammatory condition must necessarily extend upon both sides of and through the septum extending its entire length. If due to an inflammatory condition the bend or break would be found at any part of the septum and the position and shape would be different in every case. As the location upon the septum from above downward is nearly always the same and as the shape is always from before backward, inflammation could not produce it. In order to produce a fracture, there must be excess of septum. Therefore, unless the fracture is the result of a direct blow it would require years for sufficient growth and curvature to produce a condition in which fractures or even an abrupt bending could take place.

The theory that deformity is "primarily" the result of traumatism due to injury in utero or at the time of delivery or even subsequently, except by direct force and secondarily to a slow inflammatory process, will, therefore, not account for these deformities.

A theory much in favor is that of Trendelenburg. That these deformities are "due to a crowding up of a high-arched palate.

A hypothesis to be accepted must not only explain all the facts, but must exclude all other explanations. A high contracted vault or "arched palate" is never seen with the first set of teeth. Deformed palates never begin development until the sixth year and development is always completed by the twelfth. Deflected septa are often observed before the sixth year. It is necessary to settle what constitutes a high, contracted arched palate. The height of the vault must be measured to find out wherein they differ. This measurement is taken at the gum margin with instruments (Fig. 1) between the second biscuspid and first permanent molar to a point at the median line of the vault. In measurements of 4,614 [1] normal jaws, it was found that lowest was .21 of an inch, the highest .84 of an inch, with an average of .58 of an inch. In brachycephalic

1 Mouth-breathing not the cause of contracted jaws and high vaults. Dental Cosmos, November, 1891.

white heads with large jaws and normal dental arches, the vault varies in height from .37 inches lowest, to .68 inches highest. The

Fig. 1.

colored varies between lowest .50 inches and highest .75 inches. The mesocephalic white varies between .31 lowest and .68 inches highest; the colored between .50 lowest and .62 highest. The

dolichocephalic white varied between lowest .62 and highest .81; the colored between lowest .56 and highest .68.

The average height of brachycephalic vaults white is....... .54
The average height of brachycephalic vaults colored is...... .61
The average height of mesocephalic vaults white is........ .52
The average height of mesocephalic vaults colored is...... .60
The average height of dolichocephalic vaults white is....... .74
The average height of dolichocephalic vaults colored is.... .62

The height of vaults in V-shaped arches varies between lowest .71 and highest .84. The average is .55. The height of vault in saddle arches varies between lowest .71 and highest .84. The average is .60. The height of vault in semi-V and semi-saddle arches varies between lowest .75 and highest .84; average .56.

Fifty-eight one-hundredths of an inch being the average, it is evident that in the deformed vaults, there is a difference of .02 of an inch only in either direction. In the extreme brachycephalic and dolichocephalic there is but .06 of an inch. In twenty-four

Fig. 2. Fig 3.

mouth-breathers, the lowest measurement was .42; highest .75, with an average of .61. While the average is .03 of an inch higher than the average normal vault, the highest vault of mouth-breathing is .10 inches lower than the highest normal vaults. The deception as to height is due to contraction of the dental arch.

In order to classify the various forms of deformed jaws, 3,000 plaster casts were used. A palate may be high and broad, high and narrow, high and deformed. The palate could be low and broad, low and narrow and low and deformed.

Two forms of deformed dental arches and vaults were specially noticeable. The V, (Fig. 2), and the saddle (Fig. 3). All other forms were modifications of these two. There is also hypertrophy of the alveolar process partial or complete. The vault, however, is never involved. (Fig. 4). It is claimed that in mouth-breathing

Fig. 4

the muscles of the cheeks press against the sides of the jaws, carrying the jaws and teeth inwards (producing these deformities) and

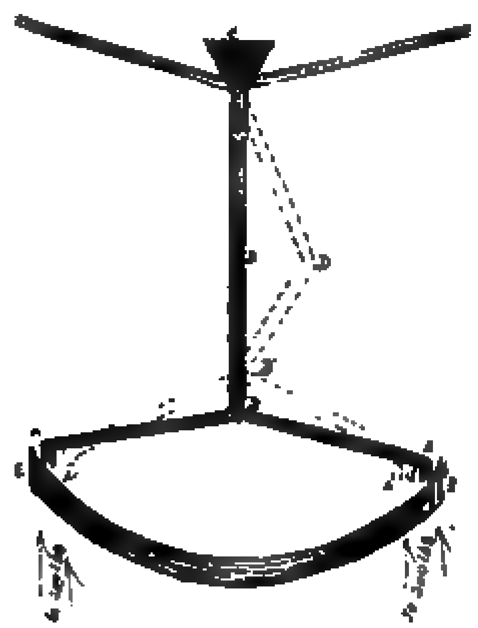

Fig. 5. After Wright.

vault upwards (Fig. 5) in this manner crowding the septum to the right or left.

In the V-shaped arch, commencing at the first permanent molar, there is gradual narrowing of the dental arch and alveolar process toward the median line, where the incisors approximate a V-point, or may stand in normal position to each other. Invariably

there is protrusion of the teeth and alveolar process, not of the jaw. In the saddle-shaped arch the biscuspids are carried inward and the deformity is invariably situated between the first permanent molar and the cuspid. Unlike the V-shaped variety, the anterior teeth and alveolar process never protrude in this class of deformities. The contracted hard palate is always associated with the V-shaped variety, in most cases extends backward to the second bicuspid, and is never seen with the saddle-shaped variety.

The vault commences to slope slightly from the neck of the incisor until it reaches an imaginary line drawn across the roof of the mouth from the right first biscuspid to the left first biscuspid, here it slopes gradually or abruptly upward until a point is reached central and vertical to a line drawn across the jaw from crest to crest, between the second biscuspids and first molars. From this point posteriorly to the soft palate, the dame is usually nearly level and parallel with the plane of the alveolar crests of the biscuspids and molars when it gradually slopes and unites with the soft palate. Occasionally there is slight depression and sometimes corresponding slight elevation. There are so inconsiderable as to escape notice unless careful examination be made.

In mouth-breathing, the lower jaw usually drops just sufficiently for the passage of the same volume of air which would pass through the nasal cavities when in normal condition. (Fig. 6.) Each open-

Fig. 6.

ing is equal to about one-half an inch in transverse area. Old people often sleep with the mouth open and to the fullest extent. These deformities of the jaws and teeth never occur after eruption of the teeth about the twelfth year.

On opening the mouth there is sense of tension of the orbicularis oris, but not of a pressure of the buccinator, no matter how

widely the mouth may open. This muscle is always passive, except in the act of blowing or eating. Contraction during sleep is out of the question. As the buccinator muscle extends anteriorly to the first biscuspid only, it cannot be productive of the V-shaped variety of deformity in which is also found the contracted vault. Therefore, the only deformity that can be so produced is the saddle-shaped variety. The orbicularis oris muscle cannot produce the contraction, since when the mouth is open the pressure, if any, on the six anterior teeth, is backward. The teeth would thus be carried in the opposite direction from that which must be taken to produce this deformity. The pressure is just as great upon the incisors as upon the cuspids, thereby holding them in place. More force is exerted by the orbicularis oris upon the six anterior teeth when the mouth is open than could be exerted by the buccinator muscle, which would tend to hold the anterior teeth in place. Apices of teeth rarely move when pressure is brought to bear upon their crowns for the purpose of regulating them. Teeth, like the cuspids, having long roots, are hence liable to move than teeth like the lateral incisors or bicuspids, with short roots. Since on moving a tooth the greatest change takes place at the neck, the greatest absorption and deposition of bone must occur at that point. The roots of the cuspids are larger and longer than those of any other teeth. Unlike other teeth, the tooth germs are situated considerably higher and farther toward the outside of the alveolar process, hence when they come closely into position they diverge from the apices to the crowns. All other teeth stand nearly or quite perpendicular, hence the roots of these do not influence the hard palate. The first permanent molar and the teeth posterior to it are never involved, except from local causes. The center of the buccinator muscle in both directions is located at this tooth. How, then, since all the teeth are covered by the muscle upon one side, could half be carried inward and the other half remain normal?

Were mouth-breathing the cause of the contraction, both sides should contract alike and the deformity be uniform upon both sides. This is never the case. Then the first permanent molars would be carried inward, which rarely ever occurs. The want of uniformity of the two sides is easily recognized. Muscles cannot contract to a degree sufficient to induce the pressure necessary to produce a deformity. Pressure of the contractile tissue upon the crowns of teeth is not sufficient to affect the alveolar process through the roots of the teeth. Even could it modify that spongy structure, its

force must stop there and not extend to the osseous vault, and result in bending it out of shape. In most cases the diameter of the superior maxilla, its alveolar process and teeth is less than that of the inferior maxilla, alveolar process and teeth. This is always the case in the worst forms of dental irregularities. In such cases, the muscles and cheek could not press upon the teeth and alveolar process of the upper jaw.

The changes which take place in the bone are not a bending in at one place and a forcing out at a weaker point to compensate for the space lost, but an absorption and deposition of bone at the point of pressure. Even if these last conditions were the case, the strong pillar of bone (the anterior alveolar process), situated at the very point of contraction of the alveolar process, would constitute a strong bulwark for resistance to the pressure, which is suppositiously acting at a distance from the center of the vault. It would be equally impossible to produce sufficient pressure from without out to break the dental arch as to break by the weight of a building the arch of a door or window. The tongue exerting much greater force in the act of swallowing, would prevent inward movement of the teeth, were the slight pressure from the cheek muscles the cause of the deformity.

Fig. 7. Fig. 8.

Were it possible for the buccinator to produce this contraction, modification of the osseous structures must be uniform. This would shut out the semi-V-shaped (Fig. 7) and semi-saddle-shaped arches entirely (Fig. 8) and a majority of other irregularities of

the teeth in which there is bi-lateral asymmetry. The bi-lateral muscle cannot act on one side while that on the opposite side remains passive. Partial V-shaped (Fig. 9) and partial saddle-shaped

Fig. 9.

(Fig. 10) arches render the theory still more untenable. In these varieties sudden bends inward occur where but one or two teeth

Fig. 10.

may be involved. These abberations could b eproduced only by centralization of force on one given point or fiber of muscle. Since the muscle is penniform in shape, it is impossible for one or two fibers of the muscle to exert their influence upon a biscuspid. (Fig. 11.) It would naturally lap two or more teeth. Lastly, the buccinator acting as all voluntary muscles do, uniformly throughout its extent of contraction, must be just as efficient below a median bisecting line in producing a narrow contracted arch as in its up-

per portion. Therefore, the lower maxilla should be contracted whenever the upper one is. This is a decided imposibility. A V-shaped arch can never occur upon the lower jaw were the teeth to articulate normally since these teeth strike inside of the upper and are thus prevented from moving forward. A saddle, partial saddle or semi-saddle arch may occur on the lower jaw, but these deformities are not often seen. When they do occur, they are the result of improper occlusion with the teeth of the upper jaw. In

Fig. 11.

semi-V and partial V-shaped arches, the alveolar process is always contracted upon the side of the deformity. If one side of the arch be contracted more than the other, the alveolar process contracts in proportion to the amount of deformity; the vault on that side is not carried up beyond the other side, which is normal. In the saddle, semi-saddle and partial saddle-shaped arches, the alveolar process is built up about the teeth in precise conformity to the nature of the shape of the arch. If three thouand models of the upper jaw be arranged in groups according to the forms here represented and the arrangement of the teeth in each group examined very closely, no two will be alike in either group. An external force acting upon the jaws from the outside could hence not possibly be a cause. Were that possible, all models of one variety would have a definite type.

On examination of twenty-four mouth-breathers, ten were found to have normal dental arches, one V, eight partial V, and three semi-V, and two semi-saddle, one of which was the result of hypertrophy of the alveolar process: The relations of the teeth to each other in deformed dental arches, therefore, are such that no one familiar with mechanical laws can accept such a theory. Pres-

sure as applied by the cheeks and lips could no more break a dental arch than a given amount of pressure break an arch of brick or stone. Those who advocate the theory of the vault being carried upward and causing deflection of the septum are certainly not familiar with the laws of mechanics nor with the anatomy of the structure under discussion.

Were it possible for the muscles of the cheeks to carry the dental arch inward, how could it affect the vault? In the first place, the movement of the teeth in the alveolar process is due to an inflammatory action producing halisteresis, Volkman's perforating canal absorption, and osteoclast absorption. There is no bending of bone in any direction in these cases. Again were it possible for the muscles of the cheeks to bend the teeth and alveolar process inwards, what effect would it have upon the vault? The thick anterior alveolar process together with the dense smooth bone in the anterior floor of the nares built like an inverted double arch with the superior maxillary bones, which form the outer walls of the nose, (Fig. 12) must convince the most skeptical that it is never

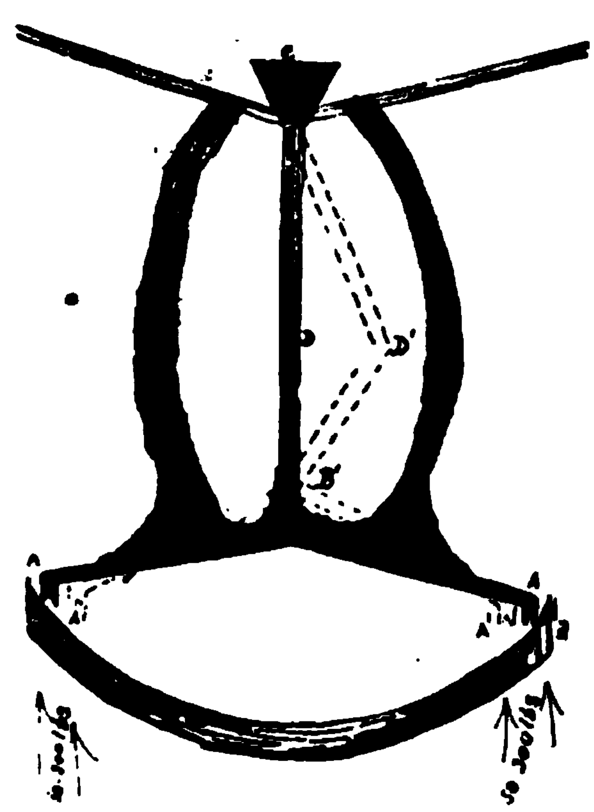

Fig. 12

pushed upward from any cause, since a larger arch is pushing against two smaller heavier arches, the two halves of the maxillary bones. To an engineer mechanic force exerted in either direction would produce no effect. There must be another cause for the deflected anterior third of the nasal septum. The greatest contraction of the dental arch is in the biscuspid region, which would naturally influence the middle third of the septum. Since the facial surfaces of the right and left superior maxillary bones form the anterior surfaces of the nose reinforce d by the lower borders of the

orbit, and the malar processes, any amount of force exerted on the alveolar process and teeth could not be exerted through these walls to influence the middle third of the septum. There being no contraction of the alveolar process at the second and third molars and very little if any at the first molar, relationship with the posterior third of the septum is out of the question.

The development of the vault can be studied from an examination of the thirty-six model drawings, given elsewhere.[1]

A ridge is sometimes observed extending from the anterior alveolar process along the entire length of the suture. This may be located entirely at the middle third. This ridge takes different shapes. (Fig. 13.) Sometimes grooves (Nos. 2 and 3) are observed upon either side of the depression. These grooves have been charged to ossification of the vomer, producing rigidity of the suture and the bone upon either side is afterward carried up.

According to Clouston, "Those palates where the deformity consisted in a ridge down the center antero-posteriorly, seemed to show that in them the deformity took place at a later period than in the other deformed palates. When the nasal septum was getting stronger and kept the center of the palate down, while on each side of it the palate was drawn up, making two vaults side by side, instead of one."

The amount of resistance in a triple arch, each fortified by the other, (Fig. 12) to say nothing of the heavy suture and thick, hard palate bracing it, would certainly suggest to any analytic mind the impossibility of such a theory. The vomer ossifies about puberty, the maxillary bones usually early in life. It seems strange that a thin, cartilaginous structure can be considered in connection with either pulling or pushing since the least deviation from a straight line would preclude such a power. These depressions are observed in vaults where the vomer is straight. They are found in lengths of from one-half to one inch in modern skulls and individuals as well as in ancient. Did the septum carry the vault down as suggested by Clouston, a like depression would be observed in the floor of the nose. In 1,367 skulls with this deformity, the floor of the nose and the connection of the septum were always smooth and evenly developed throughout its entire length. These projections are developed as early as the second year, while the vomer frequently remains unossified until eight or ten years of age, and in some cases much longer.

[1]Talbot, Osseous Deformities of the Head, Face, Jaws and Teeth.

Deformed septa are found in the early races who never have contracted high vaults. Theile, in 117 skulls, found the septum normally placed in twenty-nine. Semeleder in 49 found 35 deflected. Harrison Allen in 58 found 40 deflected. Mackenzie in

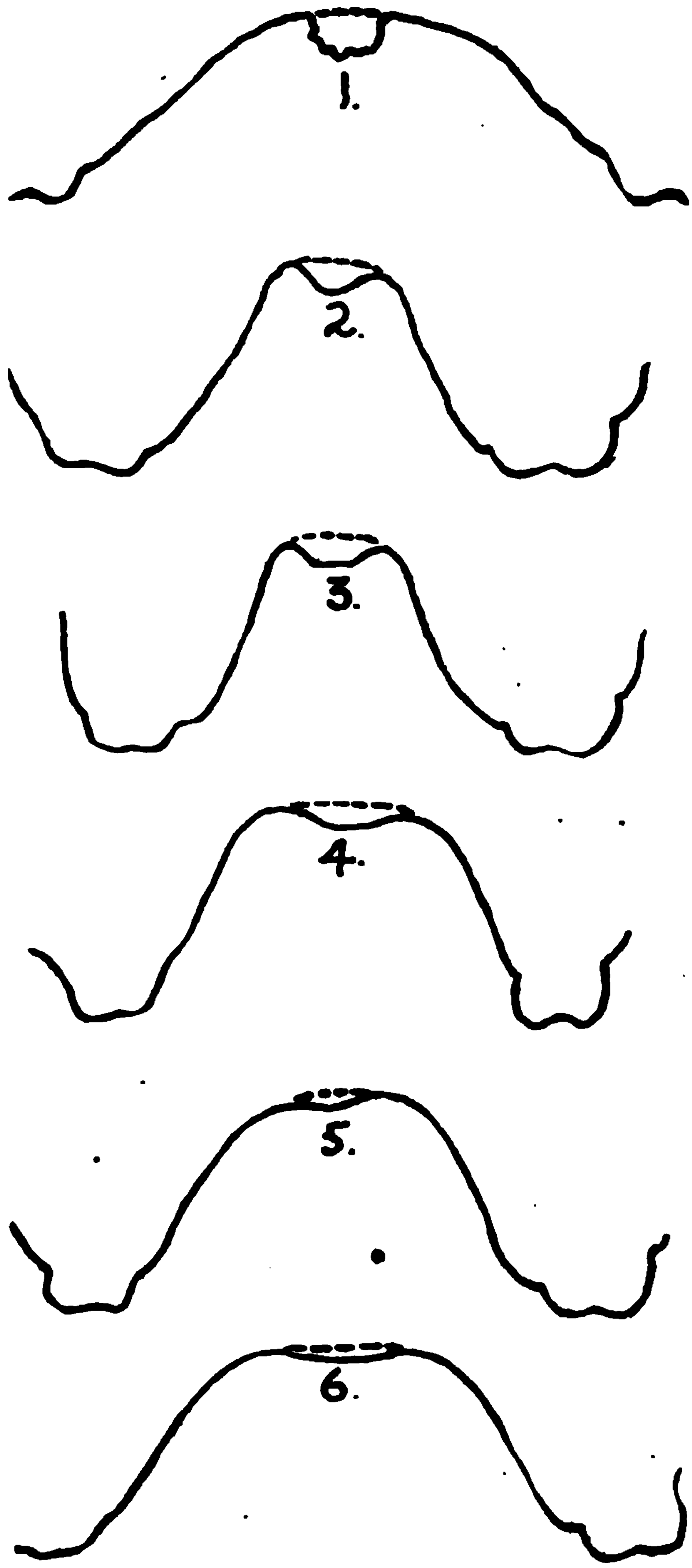

Fig. 13.

2,152 found 1,657 septa deflected. Zuckerkandl in 103 found 24 deformed. Harrison Allen found 21.5 per cent of 93 negro skulls deformed. Of 687 ancient Peruvian skulls, 147 possessed deflection.

In 67 stone-grave Indians, 34 were deformed. In 18 moundbuilders 10 were deflected. Of 6 California Indians 2 were deformed. Of 28 skulls of ancient Hawaiians, deflection of the septum was noticed in 23. Some in the anterior third, some in the middle third and others in the posterior third. This array of evidence in normal vaults and jaws conclusively destroys the theory that high vaults and contracted arches is a cause.

In 1874 I commenced investigations in a systematic way to ascertain the character and determine classification of deformities. This was followed by a study of the degenerate classes of this country and Europe and finally of peoples in the ordinary walks of life. The result of this research has been published from time to time in medical and dental journals.

It is here my intention to analyze this work in a systematic way, showing how deformities of the face, nose and jaws are produced.

To the great anatomist, Camper, belongs the credit of first studying the human face from the scientific standpoint. His name was, therefore, given to the facial angle which still serves as a standard by which to judge the rank of the human face in comparison with the lower animals. In one of his works he gives (Fig. 14) "physi-

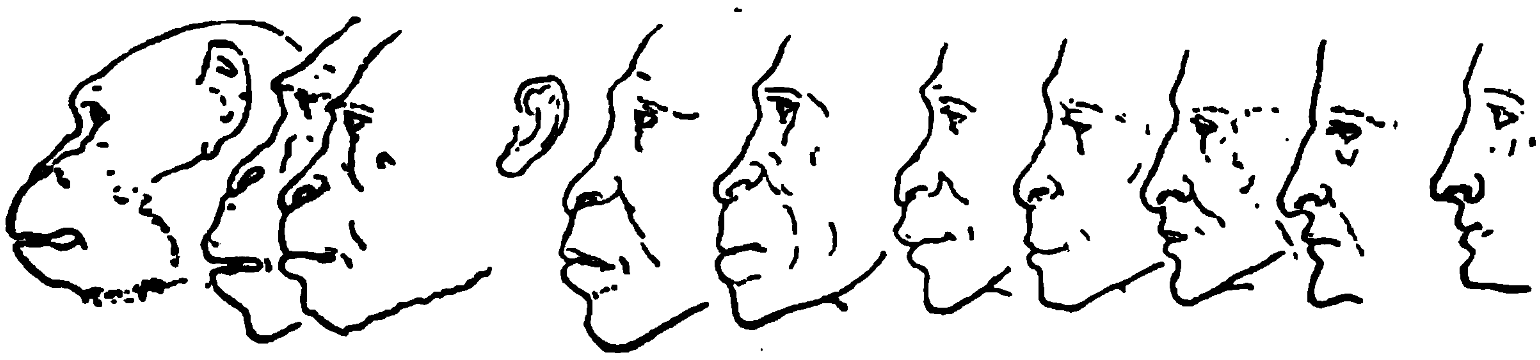

Fig. 14.

cal observation on the difference of the feature of the face considered in profile, as the heads of apes, orang-outangs, of negroes and other peoples, tracing up to antique heads. You will be astonished," he says, "to find among my first plates two heads of apes, then of negro and then of a camel."

The angle of Camper may be employed to ascertain the relation of the face to the head. (Fig. 15.) This illustration represents what Camper calls an antique head.

This imaginary line dropped from the supercillary ridge down the side of the nose will determine the existence of prognathism or orthognatism, in other words whether it is a case of arrested development or excessive development.

During a trip to Europe in 1897, observations were made on the British Isles and the Continent as to the facial angle. In most

countries casual examination was made, but where marked deformities presented themselves more careful observations were conducted. The soldiers, police and cabmen, as a rule, as well as citizens were observed. In Stockholm, on examination of 5,000 people, 2 per cent were found outside the perpendicular, 14.70 per cent on the line, and 83.30 per cent in side the line. In London examination of 10,000 faces revealed 4.13 per cent outside the line, 12.87 per cent on the line, and 83 per cent inside of the line. In an examination of 3,000 English school children (about ten years of age), 93 per cent possessedjaw s inside of the perpendicular line. Prognathism elsewhere in Europe furnishes a sufficient ocset to marked irregularities of the teeth.

a b

Fig. 15.

In comparison with these results are those obtained in Baltimore under the supervision of B Holly Smith, by William C. Palmer; in Chicago by Robert Keith under my own supervision. Those made in Baltimore showed 8 per cent outside the line, 36.5 per cent on the line and 55.5 per cent inside the line. Those in Chicago were 4.6 per cent outside the line, 14.6 per cent one the line, and 80.7 per cent inside the line.

The rapidity of evolution of the facial angle is shown in the faces of the American negroes. On examination of 357 by William Ernest Walker in New Orleans, protrusion was found in 97.5 per cent cent; on the line, 2.5 per cent. On examination by Arthur R. Dray of 686 in Philadelphia, 83.57 per cent were found to present protrusion; 15.95 per cent on the line; 1.13 per cent recession. On examination of 1,085 in Chicago, 51.06 per cent presented protrusion, 31.08 per cent one the line, and 16.6 per cent recession. Examination by Eugene F. O'Neill of negroes in Boston showed that of 1,000 454 or 45.4 per cent were protrusion, 395 or 39.5 per cent on the line, and 151 or 15.1 per cent receding. O'Neill says: "Many of the faces classed as protruding have a marked protrusion of both jaws, but have the symphysis well back of the

vertical plane. In fully one-half of the cases enumerated as protruding, the protrusion is comparatively slight and a smaller number has the typically protruding angle which is shown in the diagram."

The lateral arrest of development has been fully as great as the antero-posterior in the evolution of the face and jaws. To determine the nature of this evolution, I made numerous measurements anent these changes. The measurement of early as well as modern peoples were made on skulls obtaind from museums and crypts of churches in Europe in which last large collections of skulls are found.

Measurements were made across the upper jaw from the outer surface of one first molar to the outer surface of the corresponding molar of the other side. (Fig. 16.) These points were taken be-

Fig. 16.

cause these molars are first of the permanent set of develop, hence because developing posterior to the temporary ones, they erupt independently and are not interfered with by any in the jaw. The point of the jaw where these teeth are situated is the widest normally developed not influenced by local causes. This furthermore was most accessible. Measurements were made in persons over twenty-five years of age, because at or near this period growth is complete. After this period development is very slow. At thirty to thirty-five years it ceases altogether.

Mr. J. R. Mummery[1] and Messrs. Cartwright and Coleman examined ancient British and Roman skulls in Hythe Church, Kent,

1 Odontological Society of Great Britain.

England, and found that they measured from 2.25 inches to 2.75 inches, with an average of 2.50 inches, while the jaws of present English measure from 1.88 inches to 2.63 inches, with an average of 2.28 inches. In jaws of the early Romans measured from 2.12 to 2.62 inches, while the jaws of the present Italians measure only 1.97 to 2.62 inches; average, 2.17 inches.

In America they vary in different localities from 1.75 to 1.97 inches, lowest, and from 2.20 to 2.63 inches, highest; average from 2 to 2.19 inches. It will be seen that while there is occasionally a jaw in England, Italy and America which will measure the extreme width, the greatest change is in the lower figure and averages. This is to be expected, since in neurotics and degenerates, there is a tendency to atavism which is continually exerting its influence against arrest, which often produces jaws of the most extreme size. These figures include only the normally developed jaws. If we were to include those with arrest of development of the face and jaws, the lowest would become about 1 inch and the highest about 2 inches, with an average of .75 inches.

These examinations having been made by different persons, physicians and dentists, however, the usual allowance must be made for the personal element of error.

A tissue or organ undergoing a change in structure is a transitory structure. Transitory structures are mose easily affected than those normally developed.

This struggle for existence was very early pointed out by Aristotle in his law of economy of growth.

The law of economy of growth whereby an organ or structure is lost for the benefit of the organism as a whole is beautifully illustrated in the degeneracy of the human face. The development of the brain at the expense of the face necessitates studies of the evolution of the face from the point where Camper left them.

The dividing line in the evolution of the face must be drawn where normal development ceases and pathologic begins. At this point deformities of the nose and jaws with irregularities of the teeth become quite marked.

Having in a general way outlined the evolution going on in the human face, the causes which produce arrest and excessive development of the face, nose and jaws require attention. These turn upon the struggle of the organs for assimilable nutriment.

The questions involved in heredity and embryonic development as concerned in maldevelopment are by no means so simple as the

average practitioner or even obstetrician assumes. At the outset, every vertebrate embryo assumes the same type before definitely differentiating into its final type. Arrests of development hence produce conditions found in lower types. Some arrests may be for the benefit of the body as a whole, while others are an arrest of the type. There is a struggle for the assimilable nutriment between the different structures of the embryo. Type heredity aided by immediate atavism tends to preserve the type against gains or losses from immediate heredity since the embryonic potentialities of a type are never fully realized in the adult. Type heredity and immediate atavism sacrifice the individual for the race. Reproductive powers represent the race and to these, higher extra-uterine specialization of the individual is sacrificed. Losses through immediate heredity, if not completely overcome, aid remote atavism at the expense of type heredity and immediate atavism. This is why embryonic types result from defective heredity. The cyclops with its primitive face and nose is an arrest of development in the embryonic time when the pineal body was equal in possibilities as an eye with the bilateral eyes. On embryonic development, maternal environment exercises an enormous influence in the direction of arrested or progressive development. Maternal shock produces arrests of development which are not photographic conditions, but survivals of embryonic states. While maternal impressions do have an effect, it is simply in conditions of arrest and not in photographic reproductions of the alleged cause of the impression. Thereby, therefore, are created periods of stress around which, as Kiernan remarks, the disappearing and developing tendency necessarily centers, when certain functions and structures are to be lost by the disappearing, and others gained by the developing organs. Two most important periods of stress are the senile or simian period (Fig. 17) four and one-half months of foetal life and the period of sex differentiation. Nearly all conditions of physiologic disturbance may result at these from the influence of maternal nutrition or environment or of hereditary factors.

Among the factors which form part of maternal and paternal environment as well as the environment of childhood are climate, soil and food. These factors intermingle to a greater degree than is at first apparent. Monotony of food produces the constitutional disturbance of metabolism known as scurvy. Into this often enter conditions of depression like those resultant on confinement on shipboard or in institutions and during the Arctic winter. While

monotony of diet alone in infancy then suffices to produce scurvy (as shown in the scurvy resultant on constant use of a single infant food), still in the adult other factors are needed. In the decrease of scurvy, in modern maritime life is seen as much of the effects of rapid voyages as of improved food.

The influence of these complex factors are singularly well shown in the complex sociologic state civilization. This, while not having the malign influence usually ascribed to it, has, by its economy as regards food production and preparation, lessened markedly the

Fig. 17

functions of the jaws and teeth. Food no longer needs the grinding and tearing required from primitive man or even types as high as the "pile dwellers," whose food is still to be found even to coarse breads and cakes. Under the law of economy of growth, lessened muscular action leads to lessened blood supply. Lessened blood supply produces conditions in the offspring tending to under nutrition of certain parts for the benefit of the body as a whole and to diminution in size of unused parts. As the jaws, alveolar process and teeth are comparatively unstable in all mammals, these of necessity are peculiarly affected by disuse.

Similar evolution is occurring in the dog in whom domestication plays the part of civilization and who from a carnivore has become an omnivore.[1] In the mongrel dog, race admixture and other factors producing change in man are to be found. In him particularly does domestication play the part of civilization and jaw and tooth irregularities ascribed to other causes occur. Facility for securing food under domestication has played a part. Disuse of the jaw as a weapon by man has done its share in the changes comparatively early in development. To a certain extent this last change is still going on in the dog. In cases predisposed to advance in evolution, irregularities of beneficial type occur with great facility. In cases predisposed in the opposite direction changes result of opposite tendencies. The factors thus exerted play a part in evolution of the nose and throat.

Modern researches, not entirely supporting the doctrine that race is the mother of climate, tends to show that vital resistance in tropical and arctic climes turns more on external conditions than on race. Forty years ago the United States engineering authorities claimed that it was impossible for human beings to live the whole year in Minnesota, owing to extreme cold in winter. Now not only is the soil cultivated throughout the entire state, but still further north in Manitoba a large city has sprung up surrounded by a very considerable farming population.

The influence of food in producing systemic changes involving interference with proper osseous development, may be divided into two factors. One concerns the quality of food, and the other the quantity and variety.

The possibility, therefore, as Weismann[1] remarks is not to be rejected that influences continued for a long time (that is for generations such as temperature, climate, nourishment, etc.), which may affect the germ plasm as well as any other part of the organism, may produce a change in the constitution of the germ plasm. The influence of these factors may be exerted on the child during its intra-uterine life as well as during the extra-uterine periods of stress through its effect on maternal nutrition.

The factors entering into the struggle for existence most markedly involve the relations of the brain to the head and face. During intra-uterine life the face loses and the brain gains. This is well illustrated in the contrasted skulls (Fig. 18.) After birth the face gains at the expense of the brain. The body and face, as a

1 Talbot, Irregularities of the Teeth, Fourth Edition.

whole, so gain on the growth of the brain that as Havelock Ellis[2] remarks, further growth from the third year onward though an absolutely necessary adaptation to environment, is, to some extent, growth in degeneration and senility. The amount lost of the promise of the child is well shown in the following (Fig. 19), where the perfectly developed being fulfilling the promise of the child is contrasted with the man that the child actually becomes. Struggles for existence on the part of the different organs and systems of the body are most ardent during the periods of intra- and extra-uterine evolution and involution. At the period of sex differentiation and at the simian or senile period (Fig. 17) irregular balance given the

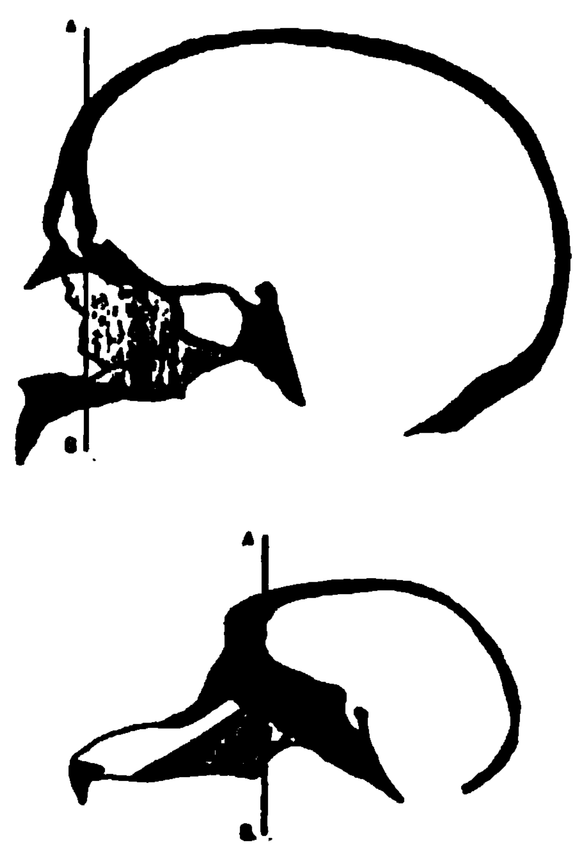

Fig. 18.

struggle for existence leads to imperfect sex differentiation or premature senility. This last often produces irregular and incomplete ossification. Since, as Harriet Alexander[3] has shown, degeneracy is a process of evolution leading to alteration of form, because of cessation of inhibition in certain directions resultant on diminished work, it logically follows that since diminished function precedes change of structure, increased function checks the change of structure in its biochemic stage. Nay, more structural elaboration due to gains from degeneracy may be retained while the degenerate structure resume their higher functions. Hence a degenerate race may rank higher in evolution because of the beneficial variations due to degeneracy. Neither degeneracy nor pathology necessarily imply malignity. The question whether degen-

1Germ Plasm.
2Man and Woman.
3Medicine, 1896.

eracy or pathologic factors be malign turns on how the structures affected stand toward the complete development of the individual. The structures of the face, as Minot,[1] has shown in man are degenerate as viewed from the vertebrate type. They are structures which quite early in evolution have been sacrificed to the gains of the central nervous system. (Fig. 19.) On them, therefore, do

Fig. 19

struggles for existence between organs leave most decided marks. The jaws and face are less marked in type with rise of evolution.

Two facial types result from arrest of development. Fig. 20 shows the arrest antero-posteriorly; Fig. 21, lateral arrest. All other forms are modifications of these two. They may become more intensely or less marked. The nose may become arrested at a much earlier date. (Fig. 22.) The lower jaw in Fig. 20 while apparently excessively developed is normal. The seeming excess is due to the face being arrested. Were it normal, the lower jaw would not appear so prominent. Because of mobility the lower jaw is more likely to be normal, in neurotics and degenerates, than the upper. The lower jaw (Fig. 21) is arrested in development.

1 Embryology.

Arrest of the face almost always involves the upper. Arrests and excessive development of the nasal bones necessarily result. The

Fig. 20.

Fig 21.

anterior nasal cavity is arrested when arrest of the face takes place.

The width of the external nasal cavity varies considerably. In 2.000 cases the greatest width was 1.25 inches; the smallest

Fig 22

width was .75 inches. The length from the nasal spine to the edge of the nasal bones was (greatest length) 1.54 inches, and the

smallest 1.20 inches. These results were found in skulls of Peruvians, stone-grave Indians, mound-builders, cliff-dwellers, Hawaiians, etc. In neurotics and degenerates, when arrest of development of the face and nose has taken place, the width measured .50 to .60 of an inch and the length .80 to .90 of an inch. In these cases, if the turbinated bone developes uniformly, the vomer will be straight. If asymmetry exist, the vomer will be deflected to one side or the other; in which case the bone, when covered with mucous membrane, will fill the cavity of the nose and mouth-breathing will result.

On general view of the nose, want of harmony in its general outline is often seen. The nasal bones are arrested in development, the tip of the nose is turned up, from a normal or excessively developed cartilage. Another very marked deformity is that in which nasal bone and cartilage are excessively developed. The bone takes one single and the cartilage another, producing a double nose. This condition is very commong among Hebrews. Americans may also have nasal organs with material enough for two fair-sized noses. In a majority of such cases, total collapse of the walls of the nose and frequently mouth-breathing results.

In over 2,000 measurements of the nasal bones, the shortest was found to be .40, the longest 1.65 of an inch in length. Even the bones without the cartilage would make a fair-sized nose. These bones take different angles. Those which are the largest take the greatest angle. A form of deformity more common than generally supposed, is that in which the nose is deflected to the right or left. This deformity, however, is often so great that it produces a marked asymmetry of the face and as oftenas slight as to be unnoticed by the average observer. It is carried to the right or left by want of harmony in development in the cartilaginous structures when only the soft tissues are involved. When the nose bones are deformed, quite another condition results. Marked deflection as well as other deformities of the nose are not observed in early life. As the face develops the deformity becomes more prominent and at puberty is well defined, although it does not reach its full extent until twenty-five or thirty years. In most instances, the two lateral halves of the face are asymmetric, as well as the nasal bones. The bones of the nose develop upon one side and deflect the lower border to the opposite side, where the bones are undeveloped. This has a tendency to deflect the cartilaginous septum in the same direction,

which, in turn exaggerates the deformity. Noses in neurotics and degenerates may be defleceed nearly forty-five degrees from a normal position. These marked deflections have been charged to injury in utero or at birth. As the bones of the nose are undeveloped at birth and as marked deflection is not observed until later in life, such a theory fails to fit the case.

At birth the nasal cavities are not evenly developed. If one side be larger than the other, more air will pass through one side than the other. If the two sides are nearly even, the amount of air will be about uniformly distributed. This, however, is not always the case. The floor of one nasal cavity may be considerably lower than the other. When this is the case one-half of the face, including ear, eye and jaw is usually lower than the other.

Fig. 28. (Zuckerkandl).

When arrest of the face occurs, there is always arrest of the upper jaw as well as the bones of the nose. When the arrest is concentrated upon a part or organ the results are a marked deformity of the part. Thus (Fig. 23) marked arrest of the face may produce a medley of small cavities instead of normal nasal cavities, antra and ethmoidal cells. The septa may develop to one side. The nasal cavity may be divided into smaller cavities and the opening into the antrum be very much enlarged. The thmoidal cells may be considerably enlarged at the expense of the nasal cavities. Deflection of the septum must therefore be considered due to a normal development on account of arrest of the bones of the face. The other mechanical in its relations to the turbinated bones.

Deflection of the septum depends upon the walls of the nose and the turbinates. The walls of the nose and the turbinates ossify before the septum, hence the septum must adapt itself to the location of these bones.

The position of the vomer depends upon the walls of the nasal cavities, the shape and size of the turbinated bones. These may be excessively developed or arrested in their development. One or both inferior turbinates may be entirely arrested. Thus the following skulls (of the Army Medical Museum at Washington) possess such deformities.

Skull No. 1,090, case 177; lower right turbinated bone undeveloped.
Skull No. 1,092, left inferior turbinated bone undeveloped, vomer gone.
Skull No. 1,094, both inferior turbinated bones undeveloped.
Skull No. 2,431, no inferior turbinated bone.
Skull No. 2,453, no inferior turbinated bone.
Skull No. 2,798, no inferior turbinated bone.
Skull No. 2,451, no left inferior turbinated bone.
Skull No. 1,216, case 180; both inferior turbinated bones undeveloped.

Many Peruvian skulls show undeveloped inferior turbinated bones. Thus:

Skull No. 630, case 166; no right inferior.
Skull No. 631, case 166; no right or left inferior.
Skull No. 115, case 167; no left inferior turbinated bone.

The vomer calcifying later in life, stimulated by air inhaled and exhaled, develops the cartilage and moulds it into a center equi-

Fig. 24. (Casselberry.)

distant between the turbinates (Fig. 24). These structures serve to warm the air taken into the lungs. This is accomplished by the air passing uniformly between them through the nose. Should defects in development arise, excessive or arrested development of bony structure occur easily in such unstable vascular structure.

Excessive development of the turbinated bones is very common. Thus, (No. 2,131, case 175, Vancouver Island Indians), the right middle turbinated bone is excessively developed, so that it fills the anterior middle of the nasal cavity with a large cavity in the cen-

ter. The left middle and right and left inferior bones were well developed, filling both nasal cavities. In this case the vomer, which stands uniformly between the turbinated bones takes the shape of the letter S. No. 2,129, Vancouver Island Indians, shows left superior turbinated bones excessively developed to a level with middle turbinated bone. The vomer is deflected to the right, then to the left in order that it may stand in a central position. Skull 1,309, case 173, illustrates the principles here laid down excellently. The right middle turbinated bone is undeveloped, the inferior right is excessively developed; the vomer in its middle takes a V-shape so as to stand in the middle between the turbinated bone.

That inhalation and exhalation govern the development and shape of the bones of the nose is shown in many ways. When the nasal cavities are small and the bones become enlarged upon one side, the outer wall becomes concave, encroaching upon the antrum. Again, when the nasal cavities are small, the turbinated bones develop and curl upon themselves, so that uniform space is obtained for passage of air. In a long, narrow nasal passage, bones will develop long and narrow; the superior turbinated bone develops down sometimes below the lower edge of the middle turbinated bone. In other cases the nasal cavities may be short and broad. Here the bones become large and short. They develop straight out from the outer wall and then turn upon themselves back to the point of origin. Sometimes they are very thin and dense, like the vomer. Again they are thick and cancellated, like the spongy alveolar process. Occasionally one nasal cavity will be lower than the other. When the nasal cavities are not uniform in development—that is, narrower in front than behind—the turbinated bones will develop posteriorly and either be undeveloped anteriorly or will curve more, so that air may be evenly distributed throughout the cavity. When the turbinated bone develops larger or smaller behind than in front, the bone will bend itself to conform to this deformity.

Skull No. 736, case 179, has a very marked deformity of the vomer which is bent in both directions. The anterior half is midway between the turbinated bones, while the posterior half is bent to the right, the greatest point being between the right upper and lower turbinated bones. Both concavities have projections one to the right, the other to the left. The anterior curvature of the vomer is the largest and for this reason the left turbinated bone is undeveloped. This, however, does not permit of sufficient air to allow

even distribution through the nostril upon one side. The procedure room the air had forced the vault of the mouth on that side downwards resulting in a markedly noticeable deformity. The dental arch is well developed.

The turbinated bones are sometimes so situated that the air deflects the vomer to one side or the other so that deformity at right angles occurs just below the inferior turbinated bone. This, however, cannot be located very near its place of attachment, since the vomer commences to enlarge or thicken as it reahes the nasal spine, thus preventing the bend.

The drawings of Zuckerkandl here given illustrate the points made.

Fig. 25 shows the bone very unevenly developed. This is partly due to an excessively developed antrum upon the left side and a

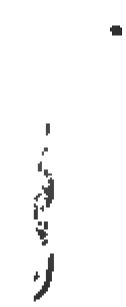

Fig. 25. (Zuckerkandl).

correspondingly small one upon the right side. The turbinated bones and vomer are so distributed that there is a uniformity of space throughout the cavity. The vomer has even deflected to the right in order to produce this harmony. The bone is, however, not broken, but simply bent and that this bend is almost opposite the enlarged left inferior turbinated bone. Although the face is very asymmetric, the bones intended for the purpose of warming the air are excellently arranged. The right cavity is considerably lower than the left, the inferior turbinated has lengthened to correspond. Aspiration has separated the lateral halves of the vomer and the space filled in with bone.

Fig. 26 presents quite another phase. Here the facial bone is uniformly developed; the antra are comparatively uniform; the turbinated bones, however, are very unevenly developed. The bend and break in the vomer are about at a point between the two turb-

inated bones and exactly opposite the excessively developed right inferior turbinated bone. The bend is no greater in the one than

Fig. 26. (Zuckerkandl.)

in Fig. 25, and yet in Fig. 26 the left plate is fractured, while the right one is slightly bent. This is usually the case. The fracture is not complete, but is a semi-fracture.

Fig. 27 excellently illustrates arrested development of the bones

Fig. 27. (Zuckerkandl).

of the face, nose and jaws. The bones are very unevenly developed with excessive development of the left superior turbinated bone, which has a cavity in it for the purpose of securing more surface for the blood supply. An individual with such a development must necessarily possess weak lungs, small chest and low vitality. In order that the air may be uniformly warmed the septum has deflected toward the right. The vomer has deflected toward the right in order that the turbinated bone may have room and also to furnish uniform space. The septum in this case is bent and not broken.

Fig. 28 illustrates another deformity occasionally observed. In this case the nasal cavities extend laterally nearly outside of the

Fig. 28. (Zuckerkandl.)

alveolar process. An attempt to open the antrum through the cavities of the teeth would result in drilling into the floor of the nose. Having such a large space the turbinated bones have adjusted themselves to the best advantage. The septum also has adapted itself as best it can by deflecting toward the left side, having bent itself at its weakest part and opposite the enlarged turbinated bone. There is, however, a large space upon the right side between the two turbinated bones. The thickness of the bone pre-

Fig. 29. (Zuckerkandl.)

vents its being bent by the pressure of air and excessive development of the vomer has taken place upon that side as a substitute. The turbinates have developed as nearly equi-distant as possible.

Fig. 29 shows the turbinated bones upon both sides excessively

and uniformly developed; as a result the vomer is straight upon the left side, while the right half has been torn away and by aspiration has been drawn slightly into the space between the two bones.

Fig. 30 and Fig. 31 are drawings taken from frozen specimens in the Army Medical Museum at Washington showing that

Fig. 30.

the parts of fracture and deflection are situated between the turbinated bones.

A skull of a fourteen-year-old girl who died of consumption had hardly a bone, including the lower jaw, that does not show stigmata of degeneracy. The left inferior turbinated bone did not develop. A simple ridge is present where the ridge should be attached to the outer wall. The right inferior turbinated bone is excessively developed. The vomer has curved to the side where

Fig. 31.

there is quite a bend, still, because the girl died at fourteen, this is not as marked as it would have been had she lived.

In another case a bone projects .36 of an inch (situated upon the

right side of the vomer just midway between the superior and inferior turbinated bones) .75 of an inch in length, 1.50 inches in from the nasal spine, and .50 of an inch from the posterior border, which is comparatively straight. The anterior part is slightly curved but perfectly straifht .50 of an inch interior to the commencement of the deformity. There is a slight groove upon the opposite side of the vomer to correspond to the line of projection. It stands just midway between the two turbinated bones. This is not a fracture, nor can it be claimed that the projection is for the purpose of repairing a fracture. The length of this projection would alone preclude such an idea. These projections vary from a mere ridge up to a projection .36 of an inch in width.

These projections were first described by Langenbeck, who gave to them the name of exostoses. They were afterwards described by Theile, Harrison Allen and John Mackenzie. "These projections," according to Bosworth, "are always found along the sutural lines of the septum and consists in a more or less well-developed angular prominence or ridge, which projecting into the nasal passage, acts to obstruct normal respiration."

This has not been my experience. I have always found them situated upon the convex surface and the greatest projection being at the weakest point of the septum. As the greatest deformity may be located at any point between the anterior and posterior edges of the bone, the greatest point of projection may occur on any part of the septum, situated about midway between the turbinated bones.

Breaks, whether of cartilage or bone and spurs, are produced in the same manner. This also accounts for division of the septum as well as for a break upon one side with a bend upon the other. The spur seems to be a supernumerary turbinated bone. Deflection and the supernumerary turbinated bone compensate for the space on either side of the nose. Just as the intelliegnce of the individual depends upon the number of nerve cells, they upon the amount of gray matter in the brain and the gray matter depends upon the number of lobes or convolutions, so the warmth of air taken into the lungs depends upon the amount of blood, the blood upon the amount of mucous membrane and this upon the contormation of the bones of the nose to produce surface. If they are arrested upon one side, those upon the other enlarge or elongate and thus make up for the deformity. When the inferior turbinated bone is entirely arrested the bend in the septum and projection

seems to compensate for the loss. In neurotics and degenerates, the lungs and the chest walls are often undeveloped and very delicate.

Mouth-breathing, then, is due to arrest of the nasal cavities and bones, excessive development of the turbinates and mucous membrane. This, together with adenoids, are the result of an unstable nervous system. That the patient may breathe through the mouth the lower jaw drops slightly (Fig. 6.) This causes the alveolar process to elongate, carrying the teeth with it, hence the high vault.

To show how different forms of contracted dental arches are produced would consume too much time. Being the result of local causes, they do not interest us at the present time. Those wishing to study the details will find them demonstrated in my work upon "Irregularities of the Teeth." All that is necessary to state is, given an arrested jaw, the teeth arrange themselves as best they can. The character of the deformities depending upon the order of development of the teeth.

ETIOLOGY OF CLEFT PALATE.[1]

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D.,
CHICAGO.

Beautiful as the human face is, in its most perfect phase, it is, as Minot has shown, from the standpoint of food-getting, an embryonic type. The jaws are needed less and less for purposes of food-getting, chewing, and combat, hence resultant disuse under the law of economy of growth sacrifices them for the benefit of the growing brain and nervous system and to the need the first has of the dermal elements of the skull. Under operation of the law of economy of growth there has occurred the esthetic evolution of the face from the anthropoid to the Apollo Belvidere type, as well as the reverse phase of this, where symmetry of the body as a whole, to preserve brain gains is sacrificed to changes in the nose, jaws, alveolar process, and teeth. This struggle for existence strains most developments of points of ossification, and as it is aided by primitive type heredity, spends much of its force on the structures which have gained for race purposes like the jaws and the teeth. The palatal bones are therefore affected.

Cleft palate is divisible into congenital and postcongenital. The postcongenital, while having a predisposing factor of teratologic nature.

[1]Read at the Fourth International Dental Congress at St. Louis, 1904.

is often produced by a determining nosologic factor. Congenital cleft palate is divisible into two kinds, complete and partial—complete, when the fissure extends the entire length from the uvula to and including the anterior alveolar process and even the lips; partial, when only a small part of the structure is involved. Thus the cleft may extend through the anterior alveolar process, involving only the incisive bones, which is very rare; when present, single or double harelip almost invariably coexists. Cases occur where a small portion of the anterior alveolar process and jaw are involved with one or two teeth. The hard palate may be merely involved to the extent of a small fissure, or the whole palate may be wanting. The soft palate may contain the cleft, or the uvula alone may. Cases occur in which the non-development of the intermaxillary bones produces lip fissures.

The problems involved in cleft palate are those of embryogeny as modified by the law of economy of growth, by remote atavism, by type heredity, and by the results of characters acquired during the periods of dentition and adolescence and prior to the senile. As soon as the external nares are separated from the mouth in the embryo, there occurs, as Minot has shown, a partition between the nasal pits and the mouth. This partition, in which the intermaxillary bone is differentiated later, is supplemented by another partition, the true palate, which shuts off the upper part of the oral cavity from the lower, thus adding the

upper part to the nasal chamber. The palate is a secondary structure which divides the mouth into an upper respiratory passage and a lower lingual or digestive passage. The palate arises as two shelf-like growths of the inner side of each maxillary process, and is completed by the union of the two shelves in the median line. The shelves so arch as to descend a certain distance into the pharynx, but in the pharynx their growth is arrested, though they may be still recognized in the adult. In the region of the tongue, which includes more than the primitive of the oral cavity, the palate shelves continue growing. At first they project obliquely downward toward the floor of the mouth, and the tongue rises high between them and appears in sections which pass through the internal nares to be about to join the internasal septum. As the lower jaw grows the floor of the mouth is lowered, and the tongue is thereby brought further away from the internasal septum. At the same time the palate shelves take a more horizontal position and pass toward one another above the tongue and below the nasal septum, and meet in the median line, where they unite. From their original position the shelves necessarily meet in front (toward the lips) first, and unite behind (toward the pharynx) later. In the human embryo, the union begins at eight weeks, and at nine weeks is completed for the region of the future hard palate, and by eleven weeks is usually completed for the soft palate also. The palate

shelves extend back across the third and second brachial arches. By migration of the first gill pouch, or in other words, of the Eustachian tube, the Eustachian opening comes to lie above the palate (uvula), while the second cleft remains lower down and lies below the palate as the outline of the tonsil. The uvula appears during the latter half of the third month as a projection of the border of the soft palate. Soon after the two palatal shelves have united, the nasal septum unites with the palate also, and thereby the permanent relations of the cavities are established.

In dealing with the influence of the factors named on embryogeny, the influences of disturbances of balance, at an early period, which would strengthen disappearing structures at the expense of later acquired structures, have to be considered. Such a disturbance would overcome the effects of disuse and create overgrowths of primitive structures at the expense of later acquired structures, leading to arrest, atrophy, or even disappearance of these last. The structures of the mouth and nose being exceedingly variable in evolution, and the structures of the jaws and teeth having in man taken an embryonic trend for the benefit of the body as a whole, under the operation of the law of economy of growth, disturbances of balance are peculiarly apt to occur here. Not only is actual growth upset by the operation of this disturbance of balance, but certain potentialities are likewise interfered with. Up to the age of three the central nervous system gains

at the expense of the other structures. After this period the other structures gain, but the nervous system, while growing, does not maintain its supremacy in growth.

Interferences with palate formation must begin comparatively early in embryogeny, and hence must imply decided defect on the part of the parents. Any maternal factor, whether arising during a particular pregnancy or inherited, may so check the development of the palate as to produce the various types of deficiency which are observed by surgeons. The influence of heredity requires no special discussion, since it is involved as a rule in serious general defect rather than in localized. Furthermore, maternal environment plays here as elsewhere an enormous part. A defective mother may be so influenced by favorable environment during the first three months of pregnancy, or by removal from bad parental environment during the same period, that the embryo would not only pass through these periods of intra-uterine stress successfully, but would likewise acquire increased potentiality of passing through the later periods successfully. On the other hand, an evil environment or an environment changed for the worse soon after impregnation unfavorably affects embryogeny.

In dealing with the development of the palate, both pre- and postcongenitally, the relations of the hypophysis or pituitary body have to be taken into account, since it has been demonstrated that this body exerts an influence

over body growth and the structures thereto related. The hypophysis arises in all vertebrates as an evagination of the ectoderm near the dorsal border of the oral plate, but is separated from the plate by a fold of the ectoderm. The hypophysis at one stage of its development in mammals is a diverticulum of the oral cavity with one wall attached to the brain and the other formed by a fold dividing the hypophysis from the mouth. The hypophysial diverticulum later elongates and its upper end expands to a considerable vesicle, the lower end remaining narrow as the pedicle. The floor of the brain forms an outgrowth behind the hypophysis which is the representative of the infundibulum. The cementing together of the buccal and cerebral ectoderm over the hypophysial area causes the formation of the two diverticula. The hypophysis then grows rapidly. The pedicle elongates and its lumen is obliterated. The mesenchyma condenses to form the base of the skull (sphenoid). The pedicle entirely aborts, but the position for its passage through the sphenoid, while remaining for some time after birth in about 10 per cent of children dying in hospitals, is ultimately obliterated by growth of the sphenoid cartilage. The infundibulum contributes to the production of the adult hypophysis in mammals, but in lower vertebrates it persists as an integral part of the brain and is differentiated into ganglionic tissue. The pointed end undergoes a knob-like enlargement, which later loses its cavity.

Although the differentiation of nervous tissue begins in it, its cells early acquire an indifferent character. It is penetrated by blood-vessels and connective tissue, but the connection with the brain is permanently retained. In the adult the knob, although regarded as the posterior lobe of the hypophysis, is in no sense a part of it. Strain on the development of the hypophysis after birth can not only produce undue growth of bone, but can also check development of it. The influence of the periods of stress during the last months of pregnancy may arrest palatal development through interference with the bone-forming function of the hypophysis. checking the development of bone and cartilage necessary to proper evolution of the palate.

"The antecedent," according to Oakley Coles, "which strikes one *a priori* as being likely to play the most important part in the production of congenital deformities is that of hereditary influence. But though it will be evident that direct influence of heredity in the production of cleft palate is marked and undeniable, no sufficient statistics have as yet been brought forward to show that the actual presence of deformity in the parent has any direct predisposing influence in the child. In other words, though the defective conditions which precede and accompany the phenomenon of cleft palate are almost certain to be referred to parental influence, it is extremely doubtful whether cleft palate is in itself transmissible." Here appears that antiquated view of heredity

which takes into account only direct transmission. Heredity involves the complex of type heredity, remote atavism, individual defects or peculiarities of immediate ancestors, maternal environment, and stress period environment. Direct heredity can occur only when, in embryonic existence, the embryogeny by the law of economy of growth is centered around a given line of least resistance during the struggle for existence between the organs for assimilable nutriment. While a defective ancestor may have defective children, the line of direct expression of the defect is interrupted by the influence of atavism, by the influence of varying environment during embryogeny, and during postnatal periods of evolutionary stress. That cleft palate may be transmissible, Demarquary, Roux, Trélat, Follin, and Duplay have shown, but such transmission is and must be rare, from the factors unfavorable to direct transmission entering into heredity, inclusive of maternal environment during embryogeny.

The deformity rarely occurs, if at all, from maternal impressions. In most of the cases which have come immediately under notice, when one parent had a cleft palate all the children have been born perfectly developed, even though dread of transmitting the deformity was never absent from the mind of the mother. In one case three members of one family have cleft palate—one 17 years, one 30 years, and the third 35. The first and last are women; the other is a married man with family without any trace of the father's deformity. No

instance of cleft palate could be found among ancestors or collateral branches of the family. In another family I have obtained the following remarkable history: G. H. C., born 1853, perfect; L. C., born 1855, single harelip and cleft palate; J. F. C., born 1856, perfect; F. W. C., born 1860, double harelip and cleft palate; H. E. C., born 1863, perfect. The paternal grandmother had cleft palate. Five per cent of 1200 criminals examined by Knecht had cleft palate. In an examination of 495 criminal boys at the Illinois State Reformatory and 1080 at the New York State Reformatory, only one case in each institution was observed. Fourteen per cent of the prostitutes examined by Pauline Tarnowsky had cleft palates. Langdon Down found only a half per cent of cleft palates among congenital idiots. Gresnor found nine cases in 14,466 children, or one in 1607. I examined 1977 feeble-minded children without finding a single case. In 207 blind but one case was observed; in 1935 deaf-mutes two cases, or about one in 1000. The percentage among the defective classes is undoubtedly much larger than among normal individuals, but early deaths explain the small percentages. Bland Sutton's experiments with dogs indicate not only the presence of this deformity among animals, but its transmissal. Hereditary defects are evident in the statistics of zoologic gardens. A keeper of the Zoologic Gardens in Philadelphia observed cleft palate in the mouths of lion cubs born in the gardens. Cleft palates were also observed in a number

of pups born in Buffalo. Ogle found that 99 per cent of the cubs born in the London Zoologic Gardens had cleft palates. This was ascribed to the artificial diet of the mother as the result of enforced captivity. Similar results in other gardens in Europe were charged to maternal feeding with meat without bone. Feeding with the whole carcass of small animals greatly diminished these deformities. If cleft palates were sometimes attributable to this cause, other bony structures should likewise be involved. It is hence not astonishing to find many rickety lions born in captivity. Cleft palate has been observed among dogs, sheep, goats, etc. The question whether domesticity does not play in them the alleged parasitic influence of civilization in man can only be solved by knowledge of deformity frequency among wild animals of the same zoologic families.

The difficulties of securing data of the occurrence of cleft palate among wild animals are sufficiently shown by the following replies to the question: "Have you ever observed cleft palate among wild animals not in captivity?"

Prof. Osborn is in Europe, but in his absence I have attempted to find an answer to your query in regard to cleft palate. I looked through Windle's 11th to 15th Report on Recent Teratological Literature (*Journal of Anatomy and Physiology*) and also in several encyclopedias and surgical books without success, and I also asked Dr. J. A. Allen, one of the leading mammalogists of the country, if he had ever noted cleft palate in wild animals not in captivity, but have not ever noted a case. WILLIAM K. GREGORY.

American Museum of Natural History, New York City.

In reply to your query I can say that I have never observed and do not recollect having heard of case of cleft palate in wild animals not in captivity.

J. SYMMINGTON.

Queens College, Belfast, Ireland.

I have not seen a case of cleft palate in any wild animal.

WM. TURNER.

Edinburgh.

I have never observed a case of cleft palate among wild animals, nor have I ever heard of one. Several years ago lion whelps were born with cleft palate in the Zoological Gardens of London.

BLAND SUTTON.

London, England.

I have only experience of wild animals bred in captivity. In the Zool. Gardens of Dublin, which I had the supervision of for many years, we have bred lions (between 200 and 300) since 1856. Only very occasionally did cleft palate or other deformity appear amongst the cubs—only once during my time, if I recollect rightly. Of course in my museum work I have had many wild animals pass through my hands which were not bred in captivity, and I never saw a case of cleft palate. At the same time it should be remembered that many collectors would reject a deformed specimen.

In London Zool. Gardens, cleft palate amongst lion cubs used to be very common, I understand.

D. J. CUNNINGHAM.

University of Edinburgh.

In reply to your letter of the 1st inst., I only know of one case of wild animals being born with cleft palate. The knowledge of this I owe to Mr. R. T. Powch, superintendent of these gardens. He informs me that a litter of tiger cubs born of wild parents were brought up by an English lady in Burmah and found to have cleft palate. As you perhaps know, lion cubs have so constantly a cleft palate that it seems almost if not quite normal for them to be so born in menageries.

FRANK E. BEDDARD.

Regent's Park, London, England.

This negative evidence is not equivalent to demonstrating absence of cleft palate among wild animals, for, as I have elsewhere pointed out, animals destroy soon after birth offspring which to them appear peculiar. Cleft palate predisposes to infection by pathogenic bacteria, and hence offspring born in a wild state are not likely to survive. Cleft palate, moreover, is quite frequently associated with deep-seated affections of the nervous system or of the locomotive apparatus.

In the evolution of the palate, ossification is the central point as regards completed development. Arrest of ossification or of its potentiality plays a considerable part in determining the permanency of cleft palate. Reported cases show that the condition is one which sometimes requires merely a temporary stimulus to growth to disappear. The arrest is one of potentiality, not of permanent development. The palate bone develops from a single center at the angle of junction of the two plates of the bone.[1] The center makes its appearance about the second month. Appearing thus early, it has an impetus which survives the stress of the different periods of intra-uterine development and maternal environment. The influence of type heredity aids rather than arrests ossification of the palate, since tendency to ossify occurs thus early.

The relationship between palatal vault deformities and cleft palate, pointed out by Oakley Coles, is that existing between atro-

[1]Gray's Anatomy.

phies, hypertrophies, and arrests of development everywhere. Instability of trophic functions is shown as much in hypertrophies as in atrophies. The instability may affect not only development, but potentialities of development, which it may arrest ere the period when the potentiality is to pass into fulfilment. The same factor which prevents sexual development at the period of puberty may prevent proper development of the vault at the sixth year. The frequency of what may be called palatal hypertrophy as compared with the deficiency shown in cleft palate is an illustration of this impetus. The ease with which the tendency to cleft palatal offsprings is remedied by diet in the menageries shows that the ossification potentialities need but a slight stimulus. Influences interfering with proper development of the hypophysis, which is in such close embryogenetic relations with the palate, interfere with the onset of ossification, or with its proper development.

From the angle of junction of the two plates of the bone ossification spreads inward to the horizontal plate, downward into the tuberosity, and upward into the vertical plate. In the fetus the horizontal plate is much longer than the vertical, and even after it is fully ossified the whole bone is at first remarkable for its shortness. The palate hence requires an additional period to develop after ossification. The complicated relations of the palate to the turbinated and maxillary bones, both under stress from the law of economy of growth as varying

structures, place it under varying conditions of nutriment, expressed either in excess or in the deficiency shown in cleft palate. The fact that the palate is permanent compared with the turbinates and the rest of the maxillary bones indicates that, aided by its early ossification tendencies, it tends to survive in the struggle for assimilable nutriment. Heredity of long standing sometimes so affects early development of the palate, however, as to give the other two bones an advantage. This occurs where the preconceptional vitality of the mother is lowered, or where the first two months after conception are periods of extreme strain for the mother. Paternal vitality when lowered affects the early conceptional period. This to some extent involves an influence on maternal vitality, since, as has been repeatedly shown, chiefly after maternal breakdown does paternal defect show itself. In Mongoloid idiocy, as W. A. Hammond[1] has shown, early pregnancies when the mother is healthy are free from such offspring, but later births are of this type.

To such extent is this maternal vitality the case that even syphilis may not arrest development. Thus, as in a case reported by Engel,[2] the husband may be infected during the second month of his wife's pregnancy and immediately infect her. A hearty boy is born with copper-colored eruption about the anus, and later coryza. These symptoms disappear under spe-

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[1]Neurologic Contribution.
[2]Kassowitz: *Jahrb. f. Kinderh.*, B. xxi.

cific treatment, not to return. The child does not have tertiary lues, but unlike the ordinary cases of congenital syphilis, the secondary stages.

The factors involved in the reproduction of congenital cleft palate are, it is clear from the foregoing facts, partly of an embryogenetic nature, which is connected with ossification evolution, which last in turn is involved in hypophysis development. These factors are not necessarily connected with heredity, albeit the influence of maternal environment cannot be completely excluded. The influences checking palatal development must be present very early in embryogeny, since the palate ossification center is quite early in evidence. The factors affecting this ossification center may entirely arrest ossification, may arrest it irregularly, or may merely arrest its potentiality. In the latter case improved maternal environment has favorable results. In hereditarily defective cases, however, there is an irregularity of balance giving an undue sway to certain early acquired structures at the expense of others later acquired which leads to increased irregularity, rather than its disappearance. The influence of hypophysis extracts on deficient osseous development is as yet merely suggested. Sufficient is known, however, to indicate that it might be well to use hypophysis extract in cleft palate on the possibility that the arrest was merely an arrest of potentiality, not an arrest of growth.

RELATIONS OF THE NOSE AND THE GENITALIA.*

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D.

The conception of the relationships between the nose and the genital organs very naturally arose from observation of the part played by olfaction in reproduction among domestic mammals, in whom the influence of olfaction on the sexual sense is unmistakable. Althaus[1] points out that animals of opposite sexes are drawn to each other by means of olfactory perceptions, and that in almost all animals the genitals during rut emit a very strong odor. Schiff, extirpating the olfactory nerves in puppies, found that as the male grew up he was unable to distinguish the female. The old associations of olfaction and volupty have continued this as an erogenous zone, even though desire produced by olfactory association has been largely replaced in man by desire from visual association.[2] The extent to which olfaction exerts an influence in this direction on man has been much underestimated. Cloquet,[3] calling attention to the eroticism excited by flowers, states that Richelieu lived in an atmosphere laden with perfume as a stimulus to volupty. Laycock[4] (a keen neurologist) found that in women love for musk and other

*Read before the January, 1904, meeting of the Chicago Academy of Medicine.

perfumes was related to volupty. Hildebrand[5] finds that olfaction is remotely connected with sexuality. Flowers occasion pleasurable sensual feelings, as witness the "Song of Solomon:" "And my hands dropped with myrrh and my fingers with sweet-smelling myrrh upon the handles of the lock." According to Most[6] sensual young peasants excite chaste girls to coitus by carrying handkerchiefs in their axillæ while dancing, and then wiping the perspiring faces of their partners with them. Olfactory impressions in man under ordinary conditions do not, Krafft-Ebing[5] claims, play quite as important a part as in animals. Binet[5] (opposing this view of Krafft-Ebing) cites the case of a medical student seated on a bench in a public park reading a book on pathology. Suddenly a violent erection disturbed him. He looked up; a woman redolent with perfume had seated herself upon the bench. He could attribute the erection to nothing but the olfactory impression. The infrequency of these cases tends to support Krafft-Ebing's view that under ordinary conditions sexual response to olfaction in man is feeble.

Respiratory disorders, however, may act as a predisposing element, intensifying a feeble response which under ordinary circumstances would not rise into consciousness. The well known eroticism of phthisical subjects is an illustration in this direction. In these respira-

tory disturbances nose and throat elements appear especially at puberty. Arrest of respiration may produce ejaculations, as has been repeatedly observed after death by hanging. A playful attempt to throttle a woman by her lover is often felt by her to be pleasurable, though the sexual side be not obvious. "In one case a woman indifferent to coitus had a longing to be throttled, and did anything to have her neck squeezed by her lover until her eyelids bulged." The strangling element associated with the *globus hystericus* is related to these phenomena as well as is eroticism due to nasal and laryngeal disorders of the erectile tissue of the nose.

The literature of India[7] (perhaps the oldest literature of Aryan speech) is peculiarly rich in poems and epigrams on the relation of the size of the feet and the nose to development of the genital organs. Nasogenital folklore is widely spread through the Aryan-speaking races.

Noscitur e pedibus (labiis) quantum sit virginis antrum,
Noscitur e naso quanta sit hasta viri.

The odor of the hair of one of Cato's ménage so disturbed his sexual desire that he gave her to one of his friends. This incident Byron referred to when he wrote:

Heroic, stoic Cato, the sententious,
Who lent his lady friend to Hortensius.

It is doubtful whether Ruth knew that there was any relation between the erectile tissues of

the turbinated bones and those of the penis, remarks Howard, but she certainly strove assiduously so to perfume herself as to attract Boaz.

Martial wrote:

Mentula tam magna est, tantus tibi, papile, nasus,
Ut possis, quoties arrigis, olfacere.

The French could not let this epigram sink into obscurity and remember Martial in the following:

Jean a le nez so gros et la verge si grande,
Qu'il peut se moucher quand il bande.

Another epigram is:

Chez une femme; petit pied, petit bijou.
Chez un homme; gros nez, gros membre.

Ovid's "Art of Love" and Martial's "Chloe and Phlogis" give numerous facts relating to the belief in the relation of size of the nose to the size of the penis:

Virgil refers to this in a poem—"that horrid one,
Beginning with Formosum Pastor Corydon."

In vasomotor cases of epistaxis arising from turgescence of the nasal erectile tissue, instances occur where this turgescence is due to a far-reaching excitation of the genital apparatus. Sexual excitation may produce epistaxis whether these excitations be voluntary or whether they result from development of the reproductive organs at puberty. In adolescence physiologic genital excitation may excite

some nosebleeds, while others result from masturbation. Joal[8] has reported five cases. Case 1 occurred in a 15-year-old masturbator. He could provoke epistaxis by masturbation, and did this to avoid punishment in school. Case 2 is a 14-year-old boy; here masturbation always produced epistaxis. Case 3 occurred in a 16-year-old boy. He had had abundant epistaxis twice after coition. When he had headache thereafter he masturbated to cure it by epistaxis. Case 4 was that of a man who became subject to epistaxis after masturbation. Case 5 occurred in a 14-year-old boy. His epistaxis resulted from masturbation, and ceased on abandonment of this. Le Marchard has reported the case of a girl affected with nasal turgescence with resulting coryza, relieved by nosebleed provoked by masturbation or by menstruation.

The erectile tissue of the nose (containing blood whose flow is checked through spasm to increase sensation), that relic of a time when smell played a greater part among the senses, is apt to be affected by degeneracy either as to its excessive or imperfect development. From this comes the bleeding of the nose already shown as an expression of sexual nerve strain at puberty, which may take the place of menstruation. The relations of odors to genital life become very demonstrable to physicians who deal with sex anomalies. The inter-relations of odor and sexual excitement have been

pointed out by Priestmann,[9] who claimed that the breath presents a special odor after coitus; by Hammond,[9] who has reported cases where the females during hysteric and other sexual excitement exhaled odors of vanilla, violet, and musk; by E. C. Seguin;[9] by T. A. McBride;[9] and by Wright.[9] McBride[9] had observed a woman who exhaled a rose odor during coitus. The presence of these odors indicates that exhalation of odors[10] in connection with sexual excitement still survives in man. The fact that odors resembling leather (so exciting to men and women alike[11]) occur in women just precedent to and during menstruation, and the further fact that women often have a pleasurable association of sexual type with the idea of being strangled,[12] are further indications of this survival.

The nose in man has retained much of the structure which enabled it to play the effectual part it does in mammal sex relations.[13] Tissues of the nose are for this reason, as I pointed out many years ago,[14] peculiarly apt to be affected by degeneracy.

Uterine asthma, according to the older clinicians, associated with dysmenorrhea, was an expression of genito-nasal relations. Fliess[15] has revived this old idea in a modified form, and based upon it a treatment for dysmenorrhea. He has, however, localized nasal relations on the dubious reflex hypothesis. Nassouer and Linder,[16] of Munich, and E. Ries,[17]

of Chicago, have since reported results similar to those of Fliess.

A case coming under my own observation is as follows: A 56-year-old man was operated on September 1, 1903, for the removal of the left cartilage of the septum of the nose owing to a previous traumatic fracture at the 16th year. No pain had been experienced until two years ago, when a continual soreness appeared at the apical end of the fracture during the winter months. The operation was decided upon, fearing more serious complications. The parts were cocainized. No pain was experienced in the operation except at one point at the lower posterior portion near the floor of the nose. As a result of this condition there was much erethism, and semen flowed continuously for three weeks, but yielded at length to local treatment, aided by treatment of the general motor irritability by camphor monobromate and conium and the operation. Spinal neurasthenia resulted, however; the legs and feet felt heavy. Erythromelalgia caused much uneasiness. The patient walked with difficulty. The tired feeling in the feet and limbs was quite noticeable four months after the operation, although the pain to a great extent decreased. The inter-relations of the nasal source of irritability and the genitalia were here demonstrable alike to physician and patient.

In the discussion Dr. N. H. Pierce pointed out the influence of menstruation on voice

changes in public singers as illustrative of throat and nose relations of the genitalia.

Dr. H. T. Byford was of opinion that suggestion played a large part in Fliess's result.

Dr. Emil Ries held that while Fliess's hypothesis was that of an enthusiastic believer in reflexes, still suggestion could be excluded in many cases benefited by his procedure in other hands.

Dr. W. L. Baum held that the fetishistic element which played such a large part in sexual phenomena could not be entirely excluded here.

Dr. J. G. Kiernan was of opinion that Binet's case illustrated olfactory relations where fetishism could be excluded.

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INHERITANCE OF CIRCUMCISION EFFECTS.

BY EUGENE S. TALBOT, M.D., D.D.S.,

Fellow of the Chicago Academy of Medicine; Professor of Oral Surgery, Woman's Medical College, Chicago.

During the course of my investigations into the problems of heredity arising out of the question of degeneracy I was frequently confronted by assertions based upon Weissmann's[1] assumptions in his chapter on supposed transmission of mutilations. It might have been safe, in view of the later partial reversal by Weissmann of his position as to the influence of nutrition on the germ plasm,[2] to have disregarded his former statements. The strongest of these were to the effect that no hereditary results had been produced by circumcision. Weissmann admitted it was certainly true that among nations which practise circumcision as a ritual, children were sometimes born with a rudimentary prepuce. This did not occur however, according to him, more frequently than in other nations where circumcision is not practised as a ritual. The truth of the last assertion is seemingly supported by some instances recently appearing in the literature. P. C. Redmondine,[3] of Los Angeles, California, has seen a large number of cases of absence of the prepuce in Hebrews which proved to be hereditary. After one confinement in a Gentile his attention was called to the child by the nurse, who thought it was deformed, because of the size and appearance of the glans penis. On examination the prepuce was found to be completely absent. On inquiry, the father and another son, born more than twenty years previously (comprising every male member of the family), were found to have been born with the glans fully exposed. He has seen a French family similarly affected.

I had for some time accepted the statements of Weissmann as to the non-inheritance of circumcision effects. This I believed was due to the healthy atavism furnished by the maternal side. My attention was, however, attracted by some researches of Dr. William Wolfe,[4] of Baltimore, which showed that two per cent. of Hebrews were born without a prepuce, and that a much larger proportion had defective ones.

This led me to institute an inquiry as to the conditions of the prepuce found by the Hebrew clergymen of Chicago engaged in performing the religious rite of circumcision.

[1] Heredity, Chapter VIII.

[2] The Germ Plasm, p. 535.

[3] Circumcision.

[4] *American Medico-Surgical Bulletin*, 1895.

Similar but much stronger results than those of Dr. Wolfe were obtained by me through the courtesy of the Reverend Drs. S. Bauer, M. A. Cohen, and B. Gordon, all of Chicago. Dr. Bauer, who has been seventeen years in the practise of the religious rite of circumcision, has circumcised 3400 boys, and has found the preputial absence in about three and one-half per cent. of the cases.

Dr. Cohen, during two decades of circumcision practise, has performed 10,000 circumcisions. He has found the prepuce wanting in 500 cases; partially developed in 300 cases; slightly developed in 2000 cases.

Dr. Gordon has performed 4400 circumcisions in twenty-five years. He has found the prepuce absent in 15 cases, partly wanting in 200, and slightly developed in 2200 cases. These, it should be remembered, are only cases where preputial deformity casually forced itself on observers who were not pursuing special investigations on this point.

Not only did I ascertain by this inquiry that among the Hebrews children were born without prepuces frequently and with defective ones much more often, but I ascertained that rabbinical literature contains disputes on the subject of the religious treatment of cases where the child has been born circumcised.

There was very early on this subject a difference of opinion between the schools of Shammai and Hillel. The school of Shammai maintains that if a child be born circumcised it is still necessary to draw from him the drop of covenant blood. The school of Hillel maintains that this is not necessary. It is in this manner that one authority reports their difference. Another authority says their dispute was not as to this point—that in fact both schools were of like opinion, that in case of a child born circumcised the drop of the blood of the covenant had still to be drawn from him on the eighth day; their dispute was relative to an adult proselyte who happened to have been born circumcised. In this case the Beth Shammai (the school of Shammai) insists upon the ritual drawing of blood. The Beth Hillel (school of Hillel) demurs that ritualistic drawing of blood was in such instance unnecessary. The rabbinical law was, however, in either instance according to Beth Shammai.

In the Medrash (the homiletic commentary of the rabbis on the Bible) nearly every prominent and pious man mentioned in the Bible, and some of the later prominent rabbis, are stated to have been born circumcised—thus *e.g.*, Moses, Samuel, Isaiah, Rabbi Akibah. The law relative to a child born circumcised was codified in 1567 A.D. in the Shulchan Aruch. Joreh Deah, Hilctroch Milah,

Beth Shammai, and Beth Hillel, quoted in it, flourished between the years 70 B.C. and 70 A.D.

It is therefore obvious that not only does circumcision produce inherited defects more frequently among the Hebrews than among other races which do not practise this rite, but that this occurs to such an extent that it has long been recognized as a subject for discussion in the religious literature of the Hebrews.

The subject merits further investigation by biologists, since the results so far obtained decidedly contradict Weissmann's statements, which he claims are based upon statistics that he fails to give. Weissmann has shown such an unchecked glowing imagination in his explanation of epilepsy by an always microbic factor unsupported by any researches, that every assertion of his should be subjected to critical analysis.

[Reprinted from November (1905) number of ILLINOIS MEDICAL BULLETIN.]

The Illinois Medical Bulletin

(THE BACILLUS)

A MONTHLY JOURNAL OF MEDICINE AND SURGERY.

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VOL. 6 NOVEMBER, 1905. NO. 3

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WHAT BECAME OF THE DAUPHIN LOUIS XVII?---A STUDY IN DENTAL JURISPRUDENCE.

BY EUGENE S. TALBOT, M. D., D. D. S., LL. D.,

Professor of Stomatology in Illinois Medical College, Fellow of the Chicago Academy of Medicine.

Among the many interesting historic problems connected with the French Revolution, that of the death of the Dauphin Louis XVII stands pre-eminent. The Dauphin was placed in the Temple under charge of Simon, the famous jailer of that prison. Under Simon's charge he remained until January, 1794, when Simon himself fell under suspicion as one of the adherents of Robespierre, and was executed toward the end of July of the same year. From January until July the prison remained without a chief official. It would have been perfectly possible to have substituted another youth for the Dauphin. There were three parties interested in this substitution—The Count of Provence (who afterward became Louis XVIII), the Count of Artois (who afterward became Charles X), and the Duke of Orleans (who afterward became King Louis Phillippe). These three parties were certainly to be benefited by the disappearance of the Dauphin. Indeed, as Dr. Cabanes points out, they had

circulated ere the downfall of the monarchy imputations against the legitimacy of all the children of Marie Antoinette, based upon that early semi-impotency of Louis XVI, which resulted from his adherent prepuce.

Simon (who was secretly much attached to the Dauphin, although publicly ostentatiously brutal) left the Dauphin in perfect health in January, 1794. A year later it was necessary to call Dr. Desault (a secret royalist) to attend him. He found a very much emaciated, scrofulous youth, whose person was unknown to him, and as to whose identity he had no direct evidence. The Dauphin, according to the prison reports, died June 9, 1795, about a month after Dr. Desault's visits. The Committee of Public Safety instituted an inquiry into the death and selected four physicians, Drs. Pelletan, Dumangin, Lassus and Jeanroy, to make the autopsy. These physicians appear to have had some doubt as to the identity of the body, since in the official report they state that they had made an autopsy upon a body stated to them to be that of the Dauphin (Louis XVII) by the officials of the Temple. The body bore evidences of prolonged and decided scrofula.

According to Dr. Amoedo, of Paris (from whose work are derived many of the facts about to be detailed), the body was interred at 7 p. m., June 10, 1795, in St. Margaret's Cemetery. In accordance with a royal ordinance (issued at the instance of Chateaubriand) a monument to the young prince was ordered after the Restoration, The resultant excavations in 1816 failed to find the casket containing the remains of the Dauphin. A host of pretenders arose, among whom may be named Mathurin, Bruneau, Richemont and Naundorff. The claims of all were rejected by the Bourbons when they came to the throne, and by Louis Phillippe, who succeeded them. Madam Simon (who was much attached to the Dauphin) firmly believed that her young charge did not die in the Temple, but was carried out in a basket of clothes and replaced by another child. She claimed that when she was an inmate of the Bicêtre as an incurable in 1806, the Dauphin visited her.

Just ere the close of the reign of Louis Phillippe a new impetus was given the problem as to the death of the Dauphin by an accidental discovery in St. Margaret's Cemetery. In erecting a building for church use near the left pillar of the side gate a leaden casket was discovered containing a skeleton. This was examined by Dr. Micent. In his report to the pastor of St. Margaret's Church he states that the skeleton was that of a child, and according to weakness or slenderness of the bones the subject must have been of a debilitated constitution or have lived under bad hygienic conditions. In his opinion the skeleton was without doubt that of Louis XVII. Dr Récamier (who examined the skeleton) was of opinion that the body was that of a subject more than 15 years old. The deceased Dauphin had barely attained the age of 11. Dr. Récamier stated that the jaws contained eight molars, two canines, and four incisors each. The subject, therefore, had twenty-eight teeth erupted. The

wisdom teeth were visible, and one was about to erupt. The teeth were very large in proportion to the jaw. The casket and skeleton were reinterred, but in such a manner that they could not be found. Later George Laggar (an advocate of the claims of the Naundorffs) insisted that the skeleton discovered in 1846 was not that of Louis XVII, and concluded therefore that the Dauphin did not die in the Temple. He demanded and obtained permission to excavate the cemetery anew. A casket was discovered on which was graven "L. XVII," from which it was believed that the casket contained the remains of the Dauphin. Drs. Backer and Bilhaut after a careful and exact examination reported as follows as to the remains:

"The subject is a male who has attained at least the age of 14 years and may be older. The state of the epiphyses of the humerus, the femur, the tibia, as well as the examination of the skull, permits this conclusion. The state of the jaws, their development and their separation, and the dental system corroborate this opinion. The upper jaw indicates the normal place of fourteen teeth. The left incisor is wanting, as well as the first great molar. The teeth are irregular. The two median incisors project in front. The second molar impinges considerably on the internal border of the dental arch. The wisdom teeth are developed, but not erupted. The two last left molars are carious, as also is the sixth-year molar. The two left incisors are also carious. The lower jaw is markedly developed and very thick. This thickness reaches more than a centimeter at the root of the last molar. The width between the two condyles of the lower jaw is eight centimeters. The size of the bone measurement, being made from the external part of one condyle to another, is twelve centimeters. Thirteen well developed teeth exist in the lower jaw. The sixth-year molar on the right side had been extracted a long time before death. That following it is in advance, but is separated from that preceding it by a much larger osseous interval than for any of the other teeth. One tooth is carious. The wisdom teeth are still in the alveolus. From the development of the head the subject must have been at least 14 years old. The upper jaw is particularly interesting because of the evolution of the teeth and the possibility of finding therein elements of diagnosis of the age of the subject. At each extremity of the upper dental arch is found the alveolus of the wisdom tooth largely gaping. One of these teeth was found in the casket; it presents the following characteristics: Its crown is complete to the neck. Its evolution is almost completed. In the center of the root the tooth is sharply separated into a soft border. Its length is eleven millimeters. These jaws carry to sixteen the number of teeth found in the upper jaw. The lower jaw has attained a great development beyond that usually found in young subjects. The removal of a molar and the obliteration of its alveolus had striking consequences for the tooth which follows it. This was the right wisdom tooth, which, less hindered in its evolution, is further advanced than the left. The upper and lower jaws belong to the same subject."

These results led to considerable discussion both among historians and anthropologists. In consequence the Paris Anthropologic Society deputed Drs. Manouvrier and Magitot to examine the remains. In their opinion the skeleton belonged to an individual at least 16 years of age, with a great probability that the age was still more advanced. The two jaws they found were of relatively feeble dimensions. The upper jaw in particular was narrow and had been affected by a certain degree of atresia, which had caused vicious implantation of corresponding teeth. This atresia had another effect, to reverse the ordinary relations of the upper and lower jaws. The teeth were not all in place, but the alveoli remained to permit them to be reconstituted. There were no milk teeth. All the teeth were permanent. The permanent teeth had all erupted except the wisdom teeth. The incisors were of moderate dimensions and normal form, with the exception of the lateral, which were somewhat atrophic. The canines were normal, but badly placed in the upper jaw. The premolars were normal in type and place, except that the two second premolars projected. The first molars were in place, but the right inferior one was absent, and had been extracted surgically long enough after its eruption to enable the cavity resultant to be filled by bone. In the opinion of the reporters this extraction had taken place toward eight or nine years. The time which had elapsed since this extraction, and which had filled the cavity, would bring the subject up to the age of 16. The wisdom teeth were all four evidently present. In all probability they were still covered with mucous membrane, but their eruption was near at hand, since the crowns were entirely formed and the roots were already several millimeters in length. This last fact tends to show that the age of the subject must have been more than 18 years, as the first trace of the crown of the wisdom teeth appears at 12 and the eruption occurs between 18 and 25.

This (which tends to prove that the skeleton was that of a subject who had reached the age of 16 at least) demolishes all probability that it belonged to Louis XVII. Furthermore, the indication furnished by the wisdom teeth that the subject was between 18 and 20 is a still more striking disproof of this hypothesis. The skeleton which was exhumed in 1846 presented appearances which led to similar conclusions. Drs. Récamier and Bayle were of opinion that the bones and teeth belonged to a subject at least 15 years old. Drs. Lallemand and Andral claimed that the age was 20, basing this opinion on the state of the wisdom teeth. Dr. Simon de L'Heivs expressed the opinion that the subject had passed 20. Magitot and Manouvrier arrived at the following conclusion: "The skeleton subjected to our examination is that of a male 1 meter 63 centimeters in height, and certainly aged from 18 to 20 years. This skeleton can not possibly belong to the Dauphin, who according to historic tradition died and was buried at ten years and two months."

At the request of the faculty of Paris Dr. Amoedo examined the dentition. He was unacquainted at that time (June 10, 1894)

with the experience of Magitot. Amoedo arrived at the following conclusion: "Given the usage of the free border of the incisor, taking into consideration the fact that on the left side of the lower jaw the space left free by the sixth-year molar has been filled by the second great molar, which is so advanced as to come in contact with the second little molar, thus favoring the development of the wisdom tooth of that side; given also the presence of two lower wisdom teeth, both of which have perforated the alveolar process, the right being more developed than the other; taking into account the fact that the upper wisdom teeth have fallen from the jaw after death, which indicates that they were not covered by the alveolar parietes and in consequence were ready to erupt; taking into account also the fact that the enamel of the teeth presents yellow stains—it must be concluded that the skull examined belongs to a subject at least 18 years old."

These results settle one question emphatically. The skeleton which has been so long received as that of Louis XVII is clearly that of a much older person. It does not settle, however, the more interesting question, What became of the Dauphin? It is true that the claims of Eleazar Williams, the so-called American Dauphin, were disproved. There was nothing specially corroborative of his claims but the Bourbon nose, which is not an uncommon possession. The Naundorffs still vigorously claim to be Bourbons. Mathurin's claim was disproved in 1846 by very positive evidence. The origin of Richemont, the third of the alleged Dauphins, is lost in obscurity. It is not even known whether the name he commonly bore was real or assumed. By the year 1834 he had made himself so notorious by his pretensions to the throne that the government of Louis Phillippe thought it necessary to take action against him. Like Mathurin, Bruneau in the reign of Louis XVIII was condemned to a term of imprisonment. He contrived, however, to escape from France after a few months' confinement, and, returning not long afterward, was allowed to live in peace. When he died under the second empire, his papers were sealed up as though containing some important secret. In the judgment pronounced against him nothing is said about his claims to the throne. He was convicted of having in 1830, 1831, 1832 and 1833 (by a resolution concerted and decided between two or more persons not known) formed a plan for destroying the government and promoting civil war. Richemont, or Baron Richemont, as he called himself, died of apoplexy in 1853 at the house of Countess Apochier, whose husband had been page at the court of Louis XVI. On his tomb was inscribed this remarkable epitaph:

HERE LIES
LOUIS CHARLES DE FRANCE,
BORN AT VERSAILLES 27 MARCH, 1785,
DIED AT GLIEZE 10 AUGUST, 1853.

Five years afterward M. de Persigny, minister of the Interior, ordered the inscription to be erased, and it was replaced by the following:

1785.

NO ONE WILL EVER SAY OVER MY TOMB,

POOR LOUIS,

HOW SAD WAS THY FATE.

PRAY FOR HIM.

While the Naundorff pretensions have been supported by some republicans, it must be admitted that what intrinsic evidence there is tends to support the claims of Richemont to be the "Lost Dauphin." The decided legal ignoring of his claim by Louis Phillippe is evidence in this direction.

SECTION II.

DEVELOPMENTAL PATHOLOGY
OF THE
ALVEOLAR PROCESS

1 PATHOLOGY OF OSTEOMALACIA OR SENILE ABSORPTION.
2 INTERSTITIAL GINGIVITIS OR SO-CALLED PYORRHOEA ALVEOLARIS.
3 INTERSTITIAL GINGIVITIS OR SCORBUTUS?
4 ENDARTERITIS OBLITERANS AND ARTERO-SCLEROSIS IN THE ALVEOLAR PROCESS.
5 PATHOLOGY OF ROOT ABSORPTION AND ALVEOLAR PROCESS.
6 PERIDENTAL ABSCESS.
7 BUCCAL EXPRESSIONS OF CONSTITUTIONAL STATES.

PATHOGENY OF OSTEOMALACIA OR SENILE ATROPHY.*

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D., CHICAGO.

The fact that pathology at most implies a disturbance of balance which causes a conflict of physiologic processes is nowhere more evident than in osteomalacia. The current error which assumes that any process aiding disease must be innately nosologic interferes with diagnosis and treatment alike. The clinical and pathologic work done on osteomalacia has been much vitiated by the viewpoint just mentioned. Osteomalacia occurs from so many nosologic states as to indicate that it arises from a process physiologic in character, but perverted to nosologic ends by anything which disturbs the balance struggle for existence between the structures.

Bones do not grow in the ordinary sense, since the bone cells cannot multiply. Apparent growth of bone is caused by destruction of bone already formed and by production of new bone. The production of new bone is due, as Minot (Embryology) points out, first to degeneration of the ossifying cartilage. Cartilage begins to be differentiated earlier than any of the mesenchymal tissues except the blood vessels and perhaps the smooth muscle cells. Cartilage undergoes a degenerative change preparatory to ossifying. This is one of the many instances in the embryo where degeneration of a particular structure is necessary for advance of the body as a whole. There are, as Minot points out, two stages in the life history of cartilage. The first (in which the cells are large) is the earlier stage and represents the maximum of development, while the second (in which the cells are shrunken and fatty) represents a later stage with more or less

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*In "Interstitial Gingivitis or So-called Pyorrhea Alveolaris" I called attention to a form of bone absorption, osteomalacia or senile absorption. Very little was said at the time, for the reason that I wished to do more research work before bringing the subject before the profession. This paper was read before the Chicago Academy of Medicine, Dec. 12, 1899, and has never been published.

Reprint from August, 1903, Dental Digest.

degeneration. In what is called ossification of cartilage (an erroneous term) the cartilage undergoes complete degeneration and disappears. Bone is derived always by direct metamorphosis of embryonic connective tissue or of embryonic cartilage and of periosteum. Bony tissue, as already remarked, does not grow except by additions to its surface. To a certain extent it depends upon a balance between the metamorphosis of embryonic connective tissue, the formation of

NO. I.

cartilage, and the function of the osteoblasts which build up and the osteoclasts which break down.

These four conditions occur in fracture. The tissue around and between the bone ends is provisional callus. The periosteum forms the external callus and the medullary tissue the internal callus. Ossification of internal callus is performed by the osteoblasts, which develop, and osteoid tissue that later by calcic deposits undergoes a change into true bone. This bone formation is often preceded by tissue of the embryonic connective type. The osteoclasts absorb bony substance in excess. Imperfect work by the osteoblast or excessive action of the osteoclast, with resultant undue embryonic tissue formation, would reproduce in a fracture the condition of tissue which occurs in osteomalacia. Osteomalacia hence depends upon the removal of inhibitions on the physiologic balance between formative and destructive functions.

Inhibitions are exercised through the nervous system. It is not

surprising, therefore, to find fully developed osteomalacia connected by many links with trophoneuroses in which similar local bone changes occur. Prominent among these are paretic dementia and locomotor ataxia. Various changes of the bones and joints, as J. G. Kiernan (*Journal of Nervous and Mental Diseases*, 1873, page 253) has pointed out, occur in paretic dementia either in the direction of osteomalacia, of premature and excessive ossification, or of hydro articuli (thickening of the articular extremities of the long bones).

NO. 2.

Similar conditions were found previously by Charcot, Ball and J. K. Mitchell in locomotor ataxia.

In other conditions where like though lesser disturbances of the physiologic balance of the struggle for assimilable nutriment occur, osteomalacia and its converse likewise develop. In pregnancy such conditions are present. So far as the woman is concerned, pregnancy, as Harriet Alexander (*Pediatrics*, January, 1901) has shown, is a pathologic balance hitherto existing in the organism. In consequence, nutrition and assimilation are increased while elimination is decreased. In pregnancy therefore occurs an autointoxication, which may express itself in major phenomena like eclampsia, or minor phenomena like the destruction of the teeth. From the influence of this last type exercised on bone growth occur not only trophic disturbances, like osteomalacia, but also, as Rokitansky (*These de*

Paris, No. 12, 1844) long ago demonstrated, osteophytes (of the cranial bones in particular). This condition, as Ducrest has shown, appears and disappears under pregnancy. While Hohl and Virchow have claimed that this condition bears merely a coincidental relation to pregnancy, corroboration of its frequency by French, German and Italian pathologists demolishes this criticism.

Osteomalacia (the halisteresis ossium of Kilian) consists anatomically of an osteitis and periosteitis in which the perfectly hard bones are decalcified and are replaced at first by lamellar connective tissue; finally this passes centrally into the round granular medullary cell. The medullary spaces and Haversian canals increase in size, the bone corpuscles partly disappear, but in part become shorter and their processes smaller. The more complete the substitution of connective tissue the more flexible the bones become. In osteomalacia corea they are, as Winckel (Text-Book of Obstetrics (American Edition) page 472) remarks, almost as yielding as wax and not soft enough to be cut. In fully developed osteomalacia therefore the cartilage formation has been replaced by connective tissue.

Winckel has shown that the conditions under which puerperal

osteomalacia develops are essentially those causing degeneration. By improvement of hygienic surroundings of Bavarian peasant women his father was able to lessen the amount of osteomalacia. It does not therefore form a single nosologic species. It is clearly connected with the trophic factors regulating bone growth, bone repair and bone existence. In its essence it is, like cancer, a reversion to embryonic conditions. While to some extent lower, the conditions found in osteomalacia are essentially those of the immature sea-squirt in its prevertebrate period. It is a general law of biology that structures in certain parts of an organism retain for the benefit of that organism lower characteristics. This being the case, there should be one structure in the body which would give a clue to the etiology and early pathology of osteomalacia. Such a structure is the alveolar process. This is situated upon the superior border of the inferior maxilla and upon the inferior border of the superior maxilla. While usually considered a part of the maxillary bones, the alveolar process should be considered separately. Its structure, embryology and functions differ completely from the structure and functions of the maxillary bone. The alveolar process is composed of soft, spongy bone of a relatively cancellous structure. As early as the eleventh week of intrauterine life calcification of the deciduous teeth commences, and by the twentieth week calcific material is quite abundantly deposited. The alveolar process, being soft and spongy, molds itself about the sacs containing the crowns of the teeth and along their roots after their eruption regardless of position in the jaw. While the alveolar process has grown rapidly it has developed up to this time just enough to cover and protect the follicles while calcification of the jaws proceeds. When the crowns have become calcified and the roots have begun to take in calcific material, absorption of the border of the process takes place in the order of eruption of the teeth. When the teeth have erupted the alveolar process develops downward and upward with the teeth until it attains the depth of the roots, which in most instances extend into the superior maxillary bones in the anterior part of the mouth, and the upper and lower teeth rest at a point in harmony with the rami. The depth to which they penetrate depends upon the length of the roots and the alveolar process, and this in turn depends upon the length of the rami. The incisive fossa, the cuspid eminence and fossa, give evidence of this

externally. The sockets are lined with extensions of the process, thus making its upper border irregular.

When the temporary teeth are shed the alveolar process is absorbed to make room for the eruption of the permanent set. The crowns of these, being larger than those of the temporary teeth, require more space and the process must enlarge to accommodate them. It then is rebuilt about the roots of the teeth on a much larger scale. When the temporary teeth are lost the alveolar process is resorbed. It is hence developed twice and absorbed thrice, provided the second set of teeth is lost. The process is a very thin unstable structure naturally well nourished with blood vessels. As the skull and brain are gaining in the struggle for existence between the face, jaws, skull and brain, the jaws with the alveolar process must decrease in size with advance. This fact and the changes just described render the process a doubly transitory structure. For this reason it is very susceptible to metabolic changes, to mineral and vegetable drugs and poisons, as well as to changes in temperature and climate. This is in part due to the readiness with which checked elimination elsewhere finds exit through the mouth and nose. The great supply of blood vessels in the alveolar process plays a part in determining elimination.

Should man live long enough, and should the physiologic process of involution set in, his second set of teeth would disappear as a consequence of osteomalacia of the senile atrophy type. The lower vertebrates are called polyphyodontia because there is a continuous succession of teeth, not a separation into two sets. In some mammals this condition persists. The pachyderms and rodents (who are connected embryologically) present phenomena analagous to that of the polyphyodontia. In the rodents, especially the nut-eating rodents, continuous growth occurs in the incisors as they are worn down. Should one of the incisors disappear the opposing one so grows as to interfere with the gnawing powers. Many a squirrel has thereby lost its life. In the elephant not more than three teeth are in use at a time. Those worn down are shed, while new teeth are added. (Tomes' Dental Anatomy, page 405.) Thus the whole number of teeth are not in place at one time. In other pachyderms, like the hyrax, similar conditions are found. Among edentates tooth conditions form a natural transition to the sauropsidae and icthyopsidae. A curious link also occurs in the monotremata, where the

duck-bill has deciduous teeth during youth which are afterwards absorbed to make way for horny plates. Judging from the conditions found in the toothed birds, the same result occurred at a phase in evolution of toothed birds from reptiles. In man, however, this degenerative process (involving absorption of the alveolar process and loss of the teeth) is continuously present in a latent way. The alveolar process is therefore more subject to change from altered metabolism due to trophic disorders of nutrition than other structures. Osteomalacia or senile absorption occurs with greater rapidity and produces more decided change in the alveolar process than in other bones. Causes which would not affect bone structure elsewhere markedly derange it.

While osteomalacia may affect the alveolar process at any period of life after the eruption of the first set of teeth, it does not usually occur until the period between twenty-five and thirty-five. Before this the osseous system is in its constructive state and lime salts are being deposited rapidly. Later in life the constructive stage is complete and material sufficient only to repair waste is deposited. At the periods of stress metabolic changes are most active—during puberty and adolescence (fourteen to twenty-five), during the climacteric (forty to sixty), when uterine involution occurs in women and prostatic involution in men, and finally during senility (from

sixty upwards), when the disease is always present to a greater or lesser degree. While in allied conditions men are most influenced, in this disorder the sexes seem to be affected about equally. Here the influence of pregnancy comes into play. Pregnancy disturbs the physiologic balance hitherto existing, especially along the line of assimilation and elimination. The well known dental effects of pregnancy (whose underlying cause affects the alveolar process) are due to this factor. This is purely a constitutional affection.

Among the causes are nonelimination of toxic substances, whether due to autointoxication, to bacterial action, or to metallic and vegetable drugs. Disorder or disease of any excretory organ (kidneys, bowels, skin or lungs) will produce the most marked effect, firstly upon the constitution of the blood, and secondly upon the alveolar process, with resultant osteomalacia.

The urine, as Bouchard has shown, contains each day in a normal individual sufficient toxins to cause death if not excreted. This condition is markedly increased after prolonged nervous explosions like those of epilepsy or hysteria. This was pointed out thirty years ago by Meynert, who demonstrated that the status epilepticus (condition of rapidly-recurring convulsions) was due to the accumula-

tions of a proteid body in the system. The status epilepticus is preceded by a decrease of toxins in the urine and succeeded by an increase. This is likewise true as to the influence of nonelimination by the other excretory organs (bowels, lungs and oral cavity), as well as to the non-exercise of its poison-destroying power by the liver. Nonelimination moreover interferes with ordinary digestive functions and hence increases its own extent. Another factor in autointoxication is production of toxic products in such quantity as to prevent destruction by organs like the liver and consequent elimination, since a product to be properly eliminated must be changed to a particular chemical type. Among the factors which affect both these elements of elimination is the power over growth and repair exercised by the nervous system. In part this influence is exerted through control of blood supply by the vasomotor nervous system, and in part by that direct control of the nervous system over tissue change which is known as its trophic function.

Both influences are affected by nerve strain. Sudden emotion may, as Bichat demonstrated decades ago, produce marked defects upon bile secretion and may occasion jaundice. Cases are far from infrequent in which emotions like jealousy produce a mimicry of gall-stone colic in neuropaths. Murchison, Christison and Thompson have traced attacks of biliary colic to jealousy. Other liver changes from sudden nervous disturbance, whether of mental type or not, are not rare. As mental impressions are communicated to the central nervous system purely through mechanical changes in the nerves, such influence must be purely material in operation. As the brain exercises a checking influence on the operations of the liver, these mental influences produce two effects. The mental shock increases the checking action of the central nervous system on the local ganglia of the liver, and destroys the checking action of the liver ganglia, and in consequence these go too fast, resulting in their exhaustion. Either of these conditions interferes with the poison-destroying action of the liver, and accumulation of waste products is the result.

What is true of the liver is true of the other organs. This is especially noticeable, as Tuke points out, in regard to the kidneys. The action of mental anxiety or suspense, in causing a copious discharge of pale fluid, is familiar enough to all, especially to the medical student about to present himself for examination, the amount being in a pretty direct ratio to his fear of being plucked. The fre-

quency of micturition may, however, arise from nervous irritability of the bladder without increase or even with diminished secretion. Still the action of the skin is usually checked, the extremities are cold, and the kidneys have to pump off the extra amount of fluid retained in the circulation. Elimination of the substance usually separated from the blood is diminished as compared with the aqueous character of the whole secretion. The odor may be affected by the emotions in man as in animals. Prout is of the opinion that mental anxiety will produce not only nonelimination but also change in the

chemical character, as indicated by odor and otherwise. Disturbances in the medulla produce, as Claude Bernard long ago showed, a markedly pale, excessive urine. These disturbances often arise from intellectual strain or emotional shock. The influence of emotional states on secreting processes, and thereby indirectly upon autointoxication states, is illustrated in the fact long ago pointed out by Tuke that pleasurable emotions increase the amount of gastric juices secreted, the opposite effect being produced by depressing passions. Beaumont found in a case of gastric fistula that anger or other severe emotions caused the gastric inner or mucous

coat to become morbidly red, dry and irritable, occasioning at the same time a temporary fit of indigestion.

The influence of fear and anxiety on the bowels is as well marked as that upon the bladder and kidneys. Apart from muscular action, defecation may become urgent or occur involuntarily from various causes. The increased secretion from the intestinal canal may occur from fear and in some cases from the altered character of the secretion itself. While in this respect the influence of fear may be inconvenient in man, it naturally assists escape in some animals, as the skunk.

Emotions powerfully excite, modify or altogether suspend, as Tuke has shown, the organic functions. This influence is transmitted not only through the vasomotor nerves but through nerves in close relation to nutrition and secretion. When the excitement is of peripheral origin in sensory or afferent nerves, it excites their function by reflex action, so that as emotion arises it may excite the central nuclei of such afferent nerves, and this stimulus be reflected upon the efferent nerves, or it may act directly through the latter. Pleasurable emotions tend to excite the processes of nutrition, hence

the excitement of certain feelings may, if definitely directed, restore healthy action to an affected part. Violent emotions modify nutrition. Various forms of disease originating in perverted or defective nutrition may be caused primarily by emotional disturbance. Emotions, by causing a larger amount of blood to be transmitted to a gland, increase sensibility and warmth and stimulate its function or directly excite the process by their influence on nerves supplying the glands. Painful emotions may modify the quality (i. e. the relative proportion of the constituents) of the secretions.

Imperfect elimination of effete matter from the lungs is a fruitful source of autointoxication. The more marked forms are those of tuberculosis, in which there is great debility and in which there is greater waste than repair. Self-poisoning is continually going on and will continue until death. The chest capacity for the inhalation of pure air is almost nil, hence the blood is improperly oxygenated and soon ceases to convey nutriment to the tissues. Eighty per cent of criminals who die of tuberculosis in prisons have undeveloped chest walls. Degeneracy therefore cuts quite a figure in the role of autointoxication. Degenerates with contracted chest walls are, however, more frequently found. Many undeveloped individuals in every walk of life for this reason have tuberculosis. People with undeveloped chest walls and chest capacity may not have tuberculosis and yet may suffer from autointoxication. Those who have had pneumonia with adhesion, and who are thus unable to oxygenate the blood, are subject to this disease. Asthmatics and hay-fever patients suffer from autointoxication and alveolar absorption. When the skin is overstrained as to excretion through kidney and bowel overstrain, the lungs are forced to take on increased work with imperfect oxygenation as a result. This is noticed in the odor of the breath in Bright's disease and in the air-hunger of diabetes, etc. In nervestrain states and in the condition described by Albu not only do excretory organs suffer but the secretions of those glands like salivary and buccal glands are so altered as to become irritants. These excretory conditions not only result upon autointoxication states but are modified by trophic nerve function alterations. By trophic changes are meant such tissue alterations as occur in morbid conditions from disordered function of the centers of nutrition. Peripheral as well as central may be involved. The well known law of Wallerian degeneration of nerve fibres is an illustration, the

posterior spinal ganglion acting as a trophic center for the fibres of the posterior root in the cord itself. Trophic action may therefore be peripheral, though in extensive changes as a rule central (cerebral or spinal) origin should be looked for.

The constitutional result of acute and chronic infection and contagions is apt to be an autointoxication plus the action of the germ toxin. All the exanthemata have at times been followed by wasting or necrosis of the alveolus. Here the condition is notably symmetric and accompanied by disorders of the osseous system elsewhere. The same is true of grip and tuberculosis. The well-marked disorder known as Riggs' disease has been charged by Peirce, Kirk, Rhein, Robin and Magitot to the direct influence of an arthritic state (gouty and rheumatic) and regarded as a special type of arthritic manifestation. The alveolus is clearly vulnerable to the toxins of many infections. It is likewise quickly affected by some autotoxic influences from disordered metabolism. Its vital resistance to these agencies is less than that of other tissues. It is the earliest sacrifice when these or any toxins disturb the harmony of the organism.

A cause other than the actions of toxins exists for implication of these parts. Whenever tissue waste, whether local or general, exceeds repair there is trophic change. This latter depends directly upon disordered local or general nervous functions. Trophic altera-

tions from the first cause appear in growth disorders of the nails and loss of hair (alopecia) after fevers, the most familiarly obvious examples of this pathologic process. Of the other type are localized atrophies where the direct intervention of toxins can be excluded. The alveolus is liable to the first form of trophic deterioration. The influence of acute diseases upon the alveolus is probably thus exerted in many cases rather than by direct infection. Where no cause has been ascertained examination directed to this factor would probably reveal it. The general failure of the trophic centers after the prime of life (in senile states), which is attended with loss of teeth and wasting of the alveoli, is the most obvious instance of trophic failure affecting the part. Even simple anemia may thus give rise to alveolar wasting.

The more marked forms of constitutional disorders (typhoid fever, pneumonia, tuberculosis, syphilis, indigestion and pregnancy, etc.) produce intense results.

The second form of trophic failure in the alveolus is less prominent, since it generally coexists with overshadowing disturbance elsewhere which it creates to a certain extent. Cruveilier noticed its occurrence associated with simple paraplegia, regarding it as of nervous causation. In facial hemiatrophy local wasting of the alveolus has appeared before the disorder has involved the jaws generally. This is sometimes due to a local cause, but its occurrence and association with other neurotrophic symptoms are suggestive.

The causes which act locally to produce direct autointoxication are the toxic effects of mercury, lead, brass, uric and other acids, potassium iodid and allied agencies, acting in a similar manner to scurvy. While it is not the intention to discuss at length the toxic action of these substances, a case may be cited in illustration of their similarity of action and results upon the tissue. Garnier and Simon (*Arch. de Med. des Enfants,* July, 1901) have observed the case of a boy suffering from an obstinate enteritis. Milk was found to disagree, so a puree of vegetables and chopped meat was given. The boy improved for a while, but hematogenous jaundice occurred. On investigation the jaundice was found to be due to the action of lead upon the liver, the lead having been introduced into the food through a meat-chopper. In this case the usual symptoms of lead poisoning were absent, but through its action on the liver jaundice had ap-

peared. Scurvy produces the same train of symptoms as the metals, through its disturbance of metabolism.

The jaws of the hereditarily defective, whether defect be in the direction of advance or degeneracy, are fruitful soil for the development of osteomalacia. In the mouths of the congenital deaf, dumb, blind, feeble-minded and delinquent children osteomalacia attacks the alveolar process before the osseous system has reached its growth. Here, as a consequence of trophic change, metabolic action and premature senility, osteomalacia may occur in connection with the first set of teeth at two years or any period thereafter. This may be called juvenile osteomalacia. Regulating teeth and senile absorption are predisposing causes to osteomalacia.

Osteomalacia of the alveolar process is almost as common among domestic and wild animals in captivity as it is in man. Wild animals in zoologic gardens without proper exercise, in close confinement, with impure air, and fed upon too-easily digested food, naturally acquire autointoxication, resulting in osteomalacia. This is particularly noticeable in monkeys, whose changes of environment render them very susceptible to disease, especially tuberculosis. Trophic changes and impaired metabolism are thereby so impressed upon monkeys that not infrequently the first teeth become prematurely loose and drop out. The horse and cow are prone to this disease. Cattle return to the stable after a summer's sojourn in the field, and then, being fed upon a changed diet without the usual exercise of cutting grass with their teeth, undergo a reaction in their jaws and osteomalacia results. "Cribbing" of the horse is a marked illustration of the uneasy feeling resultant on this reaction. Cattle fed upon brewers' grain and slop suffer most. Dogs afford the best opportunity, however, for studying inflammation and osteomalacia among animals. Nearly every dog in the dog hospital suffers with this disease. Twenty-five per cent of roving dogs at four years of age have the disease. Eighty per cent of eight-year-old, at least ninety-five per cent of twelve-year-old, and all fourteen-year-old dogs have the disease. House dogs suffer to a marked extent with osteomalacia of the alveolar process, no doubt from being trained to house cleanliness, which interferes with natural excretion, causing autointoxication and odor.

The following models show the action of osteomalacia upon the jaws and teeth. Figure 1 is that of a physician thirty-six years of

age. Figure 2 is that of a physician thirty-eight years of age. Both of these gentlemen are apparently in the best of health. One has slight indigestion, which is the cause of absorption, the other took calomel for malaria fifteen years previous, this being a predisposing cause. In each case all the teeth are involved both inside and out. Some of the teeth are becoming loose. There is no pus in either case. The gums are apparently healthy.

In consulting the literature upon this subject I find that absorption of the alveolar process and recession of the gums has always been attributed to the severe use of the toothbrush. There are certain conditions in which the tooth-brush will assist absorption of the alveolar process. These are easily observed. I refer to the position of the cuspid teeth, where they stand prominently and are the most conspicuous part of the alveolar process. The bone over the roots is as thin as tissue paper, and the slightest friction causes a low form of inflammation, which in turn produces absorption of the bone, exposing the root. The brush never, however, produces senile atrophy in other parts of the mouth.

The absorption of the alveolar process in osteomalacia is not always uniform, as sometimes only one or two teeth are involved. Local conditions modify the extent of the disease. In most cases, however, there is a gradual absorption of bone about all the teeth.

The pathology of this disease about the teeth is not unlike that of osteomalacia of the pelvis, spine and other bones of the body, as demonstrated by Hektoen, halisteresis being the principal form of absorption. Perforating canal absorption, as described by Volkmann, is very common passing through fragments of bone. Lacunar absorption is also present and osteoclasts are frequently found. Howship's lacunae containing osteoclasts are found in the margin of irregular islands of bone. This form of absorption, while nearly always present, does not cut so much figure as halisteresis, it being much slower in its action. New osteoid tissue is rarely ever seen, since this absorption is a natural destruction of bone and is never reproduced.

Here, then, is the basic explanation of interstitial gingivitis or so-called pyorrhea alveolaris—osteomalacia or senile absorption is the underlying basis of this disease.

The preceding illustrations represent the alveolar process of a man forty-eight years of age, killed in an accident. The teeth and bone

decalcified in the usual way were prepared for the microscope. Figure 3 shows four areas of bone absorption called halisteresis (melting away of bone substance). The waste products become irritants in the blood stream and set up a low form of inflammation in the Haversian canals. The inflammation thus set up produces rapid absorption. Each of these local areas enlarges until they join. In this way large areas are produced. In the center of this illustration is seen an Haversian canal with active inflammation around it. The bone is absorbed. The inflammatory process is in the trabeculæ or fibrous part of the bone. Adjoining is a large area with bone absorption, but the fibrous part of bone remains unbroken. The inflammatory process is seen throughout. At the lower border of the picture are two large areas of bone absorption. The trabeculæ are seen, with round-celled infiltration, while the center is destroyed. At the right absorption and destruction of the trabeculæ are seen to the margin of the bone.

Figure 4 shows halisteresis at two Haversian canals. One area is much larger than the other. Both have met and the area of inflammation will be much enlarged. The trabeculæ are present and filled with round-celled infiltration.

Figure 5 illustrates a large area of absorption with destruction of the fibrous tissue to a larger extent. Around the border is seen a small amount of inflamed fibrous tissue. An artery, once an Haversian canal, is also seen. About the large area are also seen three Haversian canals with the inflammatory process just beginning.

Figure 6 shows four centers of absorption at Haversian canals. Through the picture may be seen dark lines running in all directions. These are vessels of Von Ebner, through which Volkmann's canal absorption takes place. A beautiful illustration of this is the canal running from one large area of absorption to the other.

Figure 7 shows the third form of bone absorption—lacunæ or osteoclast absorption. Here a large area of bone is destroyed by these large cells.

Figure 8 is a low power, showing the distribution of the alveolar process between the roots of two teeth. Very little of the bone remains. When the trabeculæ or fibrous tissue is destroyed in large areas, and especially in transitory structures, it is rarely restored.

Résumé.—1. Osteomalacia may and does exist for years in

pelvic and other bones before the symptoms can possibly be recognized by the physican or surgeon.

2. The object of this paper is to show that osteomalacia can be studied earliest in the alveolar process.

3. The alveolar process is the most transitory structure in the body. It develops twice and is absorbed thrice if the second set of teeth is shed. The evolution of the face, whereby the jaws are decreasing in size, with the many complications thereon resultant, render the jaws and alveolar process increasingly transitory.

4. In the evolution from the lowest vertebrates up there has been continuous succession of teeth (polyphyodont), as found in some selachians, a partial continuous succession as in some mammals, and a comparatively permanent set of teeth as in man. This shedding of teeth, due to a process called senile absorption, atavistic in type, takes place in everyone to a greater or less extent after forty-five years of age. Should man live in a comparatively healthy state long enough he would lose all teeth from this process.

5. Degenerate children, from precocity due to arrested development at the senile or simion period of intrauterine life, may show symptoms of this disease in connection with the first set of teeth at from six to ten years of age. A monkey which died of tuberculosis at one year had osteomalacia which exposed the roots of all the temporary teeth, while three had dropped out.

6. Constitutional causes like autointoxication and drug poisoning are the etiologic factors. Even the mildest types of autointoxication, due to indigestion, change in climate from hot to cold, and vice versa, with corresponding change in food, giving more work to some eliminating organs and less to others, as well as mild forms of drug poisoning, may be potent in this particular.

7. The effect of autointoxication and drug poisoning is first irritation through blood streams, often causing endarteritis obliterans. Since the arteries are terminal, irritation readily causes inflammation and halisteresis.

8. Osteomalacia is as common among wild animals in captivity as in domestic animals.

9. The influence of bacteria as a cause has not been demonstrated by Koch's law.

10. If due to autointoxication, the effete matter should be removed from the system.

11. Osteomalacia or senile atrophy is the basic explanation of interstitial gingivitis or so-called pyorrhea alveolaris.

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INTERSTITIAL GINGIVITIS, OR SO-CALLED PYORRHEA ALVEOLARIS.*

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Interstitial gingivitis is a term applied to inflammation of the gums, alveolar process and peridental membrane. Pyorrhœa alveolaris suggests erroneous etiology, since it implies there must always be a flow of pus and hence the disease must always result from infection with pus microbes, it implies erroneous pathology and treatment for the same reason. This being the case, such a title is so dangerously misleading as to compel in the present stage of dental science its complete disuse. Interstitial gingivitis is always produced in wedging the teeth for filling, in regulation, in extraction, in tooth eruption, in crown and bridge-work when improperly adjusted but there may be no pyorrhœa alveolaris. Only a very small proportion of people have pus infection while everyone over twenty-five years and before that period have interstitial gingivitis.

Interstitial gingivitis is due to both local and constitutional causes. Before discussing the different causes the structures under consideration must be studied.

Because of man's advance in evolution and because of the local degeneracies thereon resultant, through the law of economy of growth whereby one structure is sacrificed for the benefit of the organism as a whole, the face, jaws, teeth, gums, alveolar process and peridental membrane (being variable structures), are predisposed to disease in their very order of evolution.

The jaws are growing smaller because large ones are not required. The structures are changing shape to adapt themselves to the new environment. Thus—instead of large, broad

*Read before the Odontological Society of Western Pennsylvania, March 9-10, 1903.

jaws with low vaults; short, broad alveolar processes with plenty of blood supply and vitality to resist mastication; teeth short, with large bell crowns to give plenty of room between the roots for considerable thickness of the alveolar process for the nourishment of the peridental membrane and support and protection of the gum tissue—small narrow jaws occur with apparently high vaults; long, slender and thin aveolar processes, which are not used in mastication with sufficient force to carry the blood for the nourishment of the tissues. The teeth are changing their shape, causing the roots to come closer together and thus lessening the area of the alveolar process.

Since man has not adjusted himself to his new environment, the face and jaws may be said to be transitory structures. The teeth in some of the lower vertebrates develop continuously. That is, they come into place, possess large foramina, serve their purpose, are shed and new teeth take their place. This is continued throughout the life of the animal, unlike this, man has but two sets. The first teeth erupt, the alveolar process builds itself about the teeth to hold them in place. These are shed, the alveolar process absorbs, the second set appear and the alveolar process builds itself about them to hold them in place. When the second set are lost or from disease the alveolar process is again absorbed.

I have demonstrated this absorption many times upon dogs. Whether it is due to an erupting tooth, the movement of teeth by wedging, correcting irregularities, after extraction or to osteomalacia, it is invariably an inflammatory process. The building up and tearing down of the alveolar process also demonstrates it a transitory structure. This, together with the evolution of the face makes the alveolar process doubly transitory. So sensitive is the alveolar process to inflammation and absorption, the slightest irritation (whether local or constitutional), will set the osteoclasts at work.

The teeth are virtually foreign bodies in the mouth. The tendency is to shed the second set as a result of atavism. The foramina are nearly closed, hence the blood pressure in the pulp is nil. The blood vessels extend through the alveolar process

and peridental membrane and stop short. Nourishment ceases, the teeth are like ivory pegs set in the jaws. In the study of the evolution of the pulp, their attachment and the use of the teeth in the scale of evolution must appeal to every scientist that the law of economy of growth resulting in degeneracy is very apparent. The blood vessels and nerve tissues, therefore, at this locality may be called terminal structures. These blood vessels do not run straight through the bone but ramify in all directions forming loops or plexus and are intimately connected with the peridental membrane and gum margin. Now as to the causes of interstitial gingivitis.

The local causes which produce interstitial gingivitis are an accumulation of tartar about the necks of the teeth, decayed teeth producing hypertrophy of the gums, unfinished fillings, gold crowns and bridge-work, artificial dentures, rapid wedging of the teeth, collections of food and everything that will produce irritation of the gum margin setting up a chronic inflammation or gingivitis. This in turn extends to the deeper tissues (the peridental membrane and alveolar process), where it becomes interstitial in character.

The constitutional causes are drug poisoning and auto-intoxication.

The causes which, acting locally, produce direct interstitial gingivitis, are the toxic effects of mercury, lead, brass, uric and other acids, potassium, iodide, and other agencies acting in a similar manner and scurvy. It is not the intention to enter into an elaborate discussion of the toxic action of these drugs, but in a general way to show the similarity in action and results upon the tissues. Scurvy, a disturbance of metabolism, produces the same train of symptoms as metals.

It is a wide-spread opinion among dentists, that in toxic cases, the gums are the first tissues involved. The fact is, however, that when the salts of mercury are taken into the system, as noted elsewhere, they act directly upon the central nervous system; later occur nausea and vomiting, tremor in the arms and hands. Besides local nerve inflammation (neuritis)

mercurial and brass poisoning produce paralysis agitans, and lead poisoning, drop wrist.

Excessive secretions of the glands of the body, especially the salivary glands, later occur with rise in temperature, gingivitis with periosteal and peridental membrane swelling, thickening of the gums and loss of the teeth. The central nerve system disturbance affects all other structures. Inflammation of the mucous membrane of the mouth, as well as of the gums and of the alimentary canal, frequently occurs, with sloughing of tissue. The kidneys become involved and are unable to carry off the effete matter. The cachexia, which resembles that of scurvy, is characterized by great debility, anæmia, emaciation, alopecia, atrophy and coarseness of the nails, with pain in the muscles and joints.

Mercury is eliminated by all excretory organs for which it has a great affinity. The soluble salts pass out by the bowels. So long as the excretory organs of the body eliminate mercury, the tissues are not affected. Small doses are eliminated but continuation of dosage soon involves the nervous system and afterwards the tissues of the body, especially the jaws. In my experiments upon dogs, the first effect of mercury is to produce vivacity and animation. This lasts for two or three days, when the limbs begin to tremble. The kidneys and bowels act at first freely. At the end of seven or eight days, paraylsis agitans occurs. There is constant trembling whether awake or asleep; loss of appetite, with slight rise of temperature. At the end of two weeks, the gums become inflamed at the margins. If the drug be continued, death occurs in about three weeks. The loss of flesh is remarkable. Miners working in mercury mines, and mirror-makers, are all affected to a greater or less extent. The nervous system is always involved. The kidneys become diseased. The hair drops out. The miners think it a happy issue from their trouble when they have lost all their teeth, or even the molars. They are henceforth exempt from suffering so far as the teeth are concerned. Many are toothless at thirty-five.

Mercury taken by the mouth is found in the urine in two

hours and in the saliva in four hours. It appears in the urine fourteen hours after it has been applied to the skin.* Althought it is believed to have passed entirely out of the system, it has been found in the brain, liver, kidneys and muscles. It is claimed that, like lead, it forms combinations with albuminoids in the tissues for a time remaining inert, to be subsequently oxidized and returned to the circulation as an active poison. While a single dose of mercury may be rapidly eliminated from the system, repeated small doses distributed over a long period are not so eliminated on account of the thickness and occlusion of the walls of the capillaries producing endarteritis obliterans, hence more or less of it is deposited in the tissue. The other drugs and acids act upon the system in a similar manner as mercury .

Auto-intoxication due to faulty metabolism, is the great cause of interstitial gingivitis resulting in pyorrhœa alveolaris, It means self-poisoning. Every disease of the human body produces auto-intoxication. Arrest of development takes place under twenty-six years of age to a greater or less extent. Marked auto-intoxication also occurs as a result of intestinal indigestion. Milder forms of auto-intoxication occur as a result of a want of harmony in bodily functions. The skin on the ends of the fingers will peel when the cold weather appears because the skin, liver, kidneys and bowels do not adjust themselves quickly to prevent accumulation of effete matter in the blood. Soldiers going from a temperate climate to Cuba and the Philippines, with change of food, had auto-intoxication and interstitial gingivitis.

In an examination of the soldiers and officers of two companies who had just returned from the Philippines, located at Fort Sheridan, Illinois, I obtained the following results: The total number examined 127. Americans 98, Irish 12, Germans 9, English 3, Norwegians 1, South American 1, Danish 1, Russians 1, Cuban 1. The ages ranged from 21 to 52. By ages the following data was obtained:

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*Twentieth Century Practice of Medicine, Vol. III, Page 935.

Age	Disease	Age	Disease
21	8	37	7
22	5	38	1
23	17	39	3
24	12	40	none
25	15	41	none
26	9	42	1
27	4	43	1
28	8	44	1
29	11	45	none
30	5	46	1
31	4	47	1
32	7	48	none
33	1	49	none
34	2	50	1
35	none	51	none
36	1	52	1

Total, 18 none; marked, 36; medium, 27; slight, 46. Percentage, 14.1 none; 28.3 marked; 21.2 medium; 36.2 slight.

In studying these figures it will be noted the largest number of cases of the disease occurred between the ages of 21 and 30. The period of life at the constructive stage when the disease should not be present. Those over forty were nearly all officers, who took better care of the mouth. It must also be noted these men lived most of the time in the open air. In the American army mostly young men are enlisted. It will be seen the effect of climate and food is very severe. Engineers and laborers in Switzerland suffered from the same cause by going from a temperate to a cold climate when engaged in building railroads on top of the mountains.

Perhaps there is no part of the United States where this disease is so prevalent and demonstrable upon the jaws as in the northwest. The sudden changes of temperature from extreme heat to cold and going from heated houses into the cold atmosphere, and *vice versa,* prevents the adjustment of the excretory organs to an equal temperature, thus resulting in auto-intoxication.

Bodily fatigue will cause gouty and rheumatic pains in the joints and interstitial gingivitis, the result of auto-intoxication. Anæmia is also a cause.

Coming to the more marked causes, the great eliminating organs must be taken into consideration, namely, the bowels, skin, kidneys and lungs.

As auto-intoxication implies self-poisoning, it logically follows, if any excretory organ fails to perform its function, the other excretory organs must do the work of that organ. This is accomplished but very imperfectly. The sweat glands perform this object normally in the summer, but with the first breath of cool weather, the glands contract and the liver and kidneys are forced to perform the work of the skin. Auto-intoxication results. Faulty elimination from the kidneys, without disease of the organs, will cause cardiac palpitation, headache, mental depression, dermatoses, rheumatism, gout, hysteria, epileptiformads and exhaustional psychoses. Asthma, hay fever, adhesion of the lungs from pneumonia, undeveloped lung and chest walls will cause blood impurities and skin eruptions from want of proper oxygenization of the blood. Faulty action of the liver followed by constipation results in sick headache, neurasthenia, drowsiness, skin eruptions, etc.

Dr. J. H. Salisbury* includes under auto-intoxication all diseases and changes in the system by which poisons resulting therefrom are not eliminated.

The more marked forms of auto-intoxication, due to disease of the liver, bowels, kidneys, skin and lungs, are more obviously existant. In health, auto-intoxication is seldom noticed until after the periods of growth are completed. Foods taken into the system are appropriated up to this period. After the tissues have obtained their normal development, although the same quantity of food is taken, as much is not required by the tissues. The waste material is carried into the blood. The amount of food required depends upon waste and repair. This depends to a great extent upon the avocation of the person. The older the person, the more effete matter needs removal. The excretory organs are unable to do the work. The effete

*Constitutional Treatment of Interstitial Gingivitis. Journal of the American Medical Association.

matter due to metabolic changes becomes a poison in the blood.

The pathologic material for the study of interstitial gingivitis in man is obtained with such difficulty in the recent state as to necessitate research upon animals. This disease was noticeably present among carnivora, casually inspected in American and European zoological gardens. Cats and dogs were also known to be liable to the disease. As the first step in investigation, two practitioners of comparative medicine, with an extensive hospital practice (Dr. Charles E. Sayre and Dr. Alsop E. Flower), were consulted as to the frequency of this disease in animals. All animals under their care suffered from it more or less, but 80 per cent. of dogs over eight years of age had the disease. Nearly every dog in the hospital under their care was so affected. These dogs comprised all breeds, from spaniels and terriers to the Newfoundland, St. Bernard and Great Dane. On examination, every phase of interstitial gingivitis was found in the mouths of these dogs, from its inception to the loss of the teeth. The number of dogs observed was twenty-seven. The roots of the teeth of some were covered with deposits and so exposed that the teeth could be removed with the fingers. Such diseased mouths are rarely, if ever, present in human beings. The outer plate of bone was absorbed, the roots entirely exposed, pus was oozing from around them and the mucous membrane was badly inflamed. It should be remembered that the jaw of the dog, like the jaw of man, is undergoing considerable variation. Like man, the dog, having put himself under new social conditions (so to speak), is varying greatly both as to brain, skull and jaw from his wolf-like ancestor. As he is under the protection of man. the struggle for existence as to food is less intense than in the wild state, and consequently there is less occasion, even for fighting purposes, of his jaws and teeth.

Independently of conditions of this type, many of the dogs suffered from constitutional disorders. Eight had skin diseases, which in the dog are more likely to produce obvious constitutional defects than in man. Some were old and blind. Some had been injured and were under treatment for

wounds. Some were suffering from rachitis, nervous diseases, and were over-bred. Others were constipated or had germ-types of diarrhœa. One had kidney inflammation and bronchitis with high fever. In short, these dogs, being house

Fig. 1.

dogs, presented most of the constitutional diseases to which man is liable. Animals trained to house cleanliness are more prone to this disease.

The mouth of a Scotch terrier is shown in Fig. 1. The molar and premolar had been removed with the fingers. The

cuspids and incisors are quite loose. There are large deposits of tartar. The gum and alveolar process has been absorbed nearly one-half the length of the roots of the teeth. In Fig. 2 is seen the mouth of a Boston terrier with the incisors and

FIG. 2.

premolars removed. There is extreme pyorrhœa. There are calcic deposits upon the cuspids and molars. There is recession of the gums and alveolar process. In Fig. 3 is shown the mouth of another Boston terrier. In it one premolar in the upper and one on the lower jaw have been extracted. There

is extensive inflammation of the gum about the molar, cuspid and incisor, with large calcic deposits about the teeth. In Fig. 4 are shown teeth covered with calcic deposit the entire length of the root. These teeth were removed by the fingers from

Fig. 3.

the mouths of two dogs, one of whom was later obtained for scientific study. This was all the material to be obtained from the hospital, since the dogs were pets that had been placed under treatment by their owners.

Through the courtesy of Poundmaster Hugh Curran, the

necessary material was obtained from the Chicago dog pound. Here from four hundred to a thousand dogs are killed per week during June, July and August each year. Ninety-five per cent. are mongrel curs leading a street life; hence neither luxurious diet nor luxurious care can be charged with any disease in them. They have, at least, plenty of outdoor exercise and fresh air. Voiding urine frequently is in their favor. Many, despite this reversion to the life of their wolf-like ancestors, have skin diseases and are deaf and blind from old age. The bodies were secured after death, at which time examinations of the mouths were made. Five per cent. of the dogs entering the pound are of good breeds. These, if not called for by the owners, are sold for a moderate price.

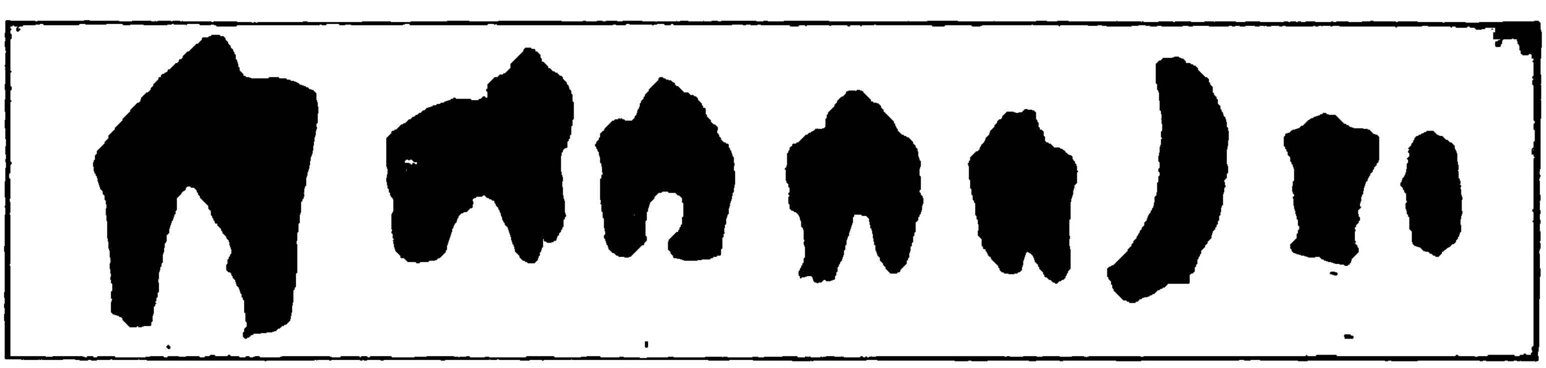

FIG. 4.

The dogs selected for the death penalty are collected in a large box-pen, leading out of which is a door through which they pass into an air-tight box. Communicating with this box is a stove in which sulphur is burned with charcoal. The fumes pass into the box and death is almost instantaneous and painless. After they remain fifteen minutes a door leading into the air is opened and the bodies are carted away. It was at this time that access was had to them. The mouths were then examined. Such cases as were of interest were placed on one side and the jaws removed from the bodies. Inside of one-half hour, the specimens were in a solution to be kept until desired for use. Jaws (with interstitial gingivitis in all stages of progress, from simple inflammation of the gums to the most extreme cases of exfoliation of the teeth), were obtained in an abundance for future studies. It is not an easy matter

to ascertain the ages of these animals. In a general way, it was found that inflammation of the gums, especially about the canine teeth, was almost always present in dogs over one year. About 25 per cent. of these dogs at four years of age had the disease; 80 per cent. at from eight to ten years; 95 per cent. over twelve years of age. Since I commenced my investigation (four years ago), I have examined quite a large number of dogs about homes, but have never found a dog over four years without this disease to a greater or less extent. Many house dogs at one year had inflammation of the gums. Dogs

Fig. 5.

for infection and those used for mercurialization were picked up in the streets.

Most of the dogs exhibited at the last three dog shows held in Chicago were young, ranging from one to four years of age. About 25 per cent. would range four years to eight. Three years ago, on a casual examination of the mouths, interstitial gingivitis was found to be common. Occasionally recession of the gums and pyorrhœa alveolaris occurred. During the last two years, on more careful examina-

tion, 25 per cent. of dogs between the ages of one and four were found to have interstitial gingivitis, and 75 per cent. of dogs from four to eight years were found to have interstitial gingivitis with recession of the gums and pyorrhœa alveolaris. In the study of this disease, therefore, dogs are excellent substitutes, since for pathologic research they can be obtained at any stage of the disease.

That other animals suffer from this disease may be noted. Fig. 5 shows the skull of a monkey who died at one year due to tuberculosis. Absorption of the alveolar process, the result of auto-intoxication is most marked. The right superior and inferior central and lateral incisors have dropped out. The other teeth could be removed with the fingers. The cribbing of the horse after the summer outing is the result of uneasiness in the alveolar process from disuse of the teeth producing interstitial gingivitis.*

TREATMENT.

In the severer types of disease, such as tuberculosis, asthma, chronic indigestion, kidney disease, locomotor ataxia, paretic dementia, etc., very little curative effect is to be expected from treatment. Constitutional treatment is tentative since auto-intoxication will continue in most cases until death. The chief treatment of such cases will be removal of local irritation. The eliminating organs must be kept as near normal as possible. If one is diseased, it must be put to rest and the others must do its work. This cannot be very satisfactorily accomplished. The alveolar process being a transitory structure and therefore very sensitive to tissue changes, the least disturbance to the nervous system and faulty metabolism will cause absorption.

Each and every disease of the body must be treated and the organs restored to health. The normal function must be restored.

Auto-intoxication may be due to slight causes such as colds

*For illustration of the pathology, see Interstitial Gingivitis or So-Called Pyorrhea, Talbot.

producing inflammation of the mucous membrane of the nose, throat, mouth extending to the gums, bronchitis, skin diseases, eruptions, constipation, indigestion, etc.

The condition of the blood should be ascertained. Unfortunately at the present time, there is no means by which this can be accomplished. An examination of the urine, however, is indicated as the next best method of demonstrating the condition of the system. A safe and delicate test can be accomplished by determining the alkalinity of the urine, saliva, perspiration, expectoration and dejection. The dentist is fortunate in this because he has every convenience at hand. Liebreich's methods of the use of plaster of Paris plates as elaborated by A. H. Hoy,* of Chicago, is most admirably adapted for this purpose, since the test can be readily applied. To make the plates, mix a very thin quantity of dental plaster to the consistency of cream, care being taken to thoroughly incorporate the plaster. Take two panes of window glass, cut four pieces of wood three-sixteenths of an inch in thickness, and place one at each corner of the glass; now pour the plaster into the center, place the other plate of glass above and press it down upon the blocks of wood. By this method a very smooth surface can be obtained. Make a round cutter out of tin, the size of a 25c. piece. Remove the upper piece by sliding it off, cut out disks just before the plaster hardens. These are prepared in the followning manner: A solution of litmus in twelve parts of water is rendered alkaline or bright blue by adding a few drops of aqua ammonia. After the disks have become perfectly hard, the smooth polished surface is to be painted with the solution, using a camel's hair brush. Two or three applications are to be made, until an even blue stain is obtained. Have a solution of chemically pure sulphuric acid, two parts in five hundred of distilled water, ready in a bottle and a bottle of distilled water. To prepare the disk for the test, scrape one-half of the dark blue surface of the plate until a slight blue surface is obtained. This requires the removal of only a slight

*Eating and Drinking.

amount, since the blue stain only penetrates a short distance. With a small brush dipped into the acid, draw it quickly over the surface exposed, giving a red appearance to the field adjoining the blue.* A bit of cotton, wound around the end of a tooth-pick wet with distilled water and applied to the two colors will produce no change, thus proving everything to be in working order. The fluid to be tested—urine, saliva, or perspiration—may now be applied. When possible, the exudate must be applied to the test as soon as it leaves the body, care being taken to apply a fixed amount each time. Apply the fluid to be examined to both the blue and red fields. When saliva is used, the mouth must be rinsed two or three times and the quantity first sucked out of the ducts must not be used. Fresh saliva direct from the glands should be used. The plates after they have been used, may be restained and used indefinitely. The dentist should make repeated tests of the secretions of healthy individuals under different conditions before studying those of diseased conditions. This method is a more delicate test than it is possible to make even with litmus paper. Litmus paper often fails to reveal reaction, which will be most obvious by this method.

The secretions of the body, if found to be acid, must be placed in an amphoteric condition as soon as possible. An amphoteric condition is a reaction of the urine by which both the blue and red litmus are affected. If the red becomes blue and the blue red, it indicates that there is an amphoteric reaction. The salt giving the alkaline reaction is the trisodic phosphate; that giving the acid reaction is the monasodic phosphate. When a uniform color is produced it shows that the alkaline and acid salts are being properly excreted in proper amounts with no excess of free acid.

The normal urine specific gravity is 1018 to 1025. To determine the specific gravity the morning urine should be used. If about 1018 or lower and acid, it is due to fermentation in

*It is almost impossible to obtain a satisfactory permanent red litmus. By this method the red and blue fields stand out in bold contrast.

the small intestines. In such cases avoid yeast bread, acid fruits, wines, vinegar and all acids. If specific gravity is 1025 or more and acid, avoid meats.

Turkish baths should be used to open the pores of the skin at which time the massuer should be instructed to stimulate the liver, kidneys, skin and peripheral nerves. Drugs should be employed to stimulate the liver. If due to mineral poisons or scurvy the poison must be eliminated from the system. The system excretes forty ounces of water daily. If this amount be not taken into the system or if it be not eliminated every twenty-four hours, auto-intoxication will follow. Every drop of water taken into the stomach enters the blood. It is one of the best purifiers which we possess. From five to seven pints of pure water should be taken each day, to flush the blood and kidneys and thus cleanse the system. Certain patients, especially neurasthenics, nervous dyspeptics and many lithæmics have a repulsion to pure water. The water can be adjusted to these idiosyncrasies by the employment of lithia or other effervescent tablets. I am getting splendid results with thialion, a laxative salt of lithia. The main object is to preserve in such cases the prominent idea of the water being medicated. Besides the use of water, dietetics in dentistry involve chiefly a conservative question.

Under most conditions of sub-oxidation and imperfect elimination, as elsewhere shown, the gums are forced to assume an excretory energy to which they are unequal. As a consequence a foundation is laid for interstitial gingivitis, which, in all of its types, may seriously threaten the integrity of the teeth. Nay, more, by furnishing a culture medium for pus microbes it may threaten the general health not only through systemic infection, but also through its interference with proper gastro-intestinal digestion. Among the restrictions in diet which dental hygiene demands is, first, a restriction in foods and water containing an excess of lime salts, which produce tartar. As excess of foods containing nitrogen, when aided by an imperfect assimilation of the carbo-hydrates, tend to produce constitutional conditions like lithæmia, gout, etc., which affect

tissue nutrition of the gums, these foods require restriction and adaptation to the particular case.

The local treatment should be, removal of all deposits from

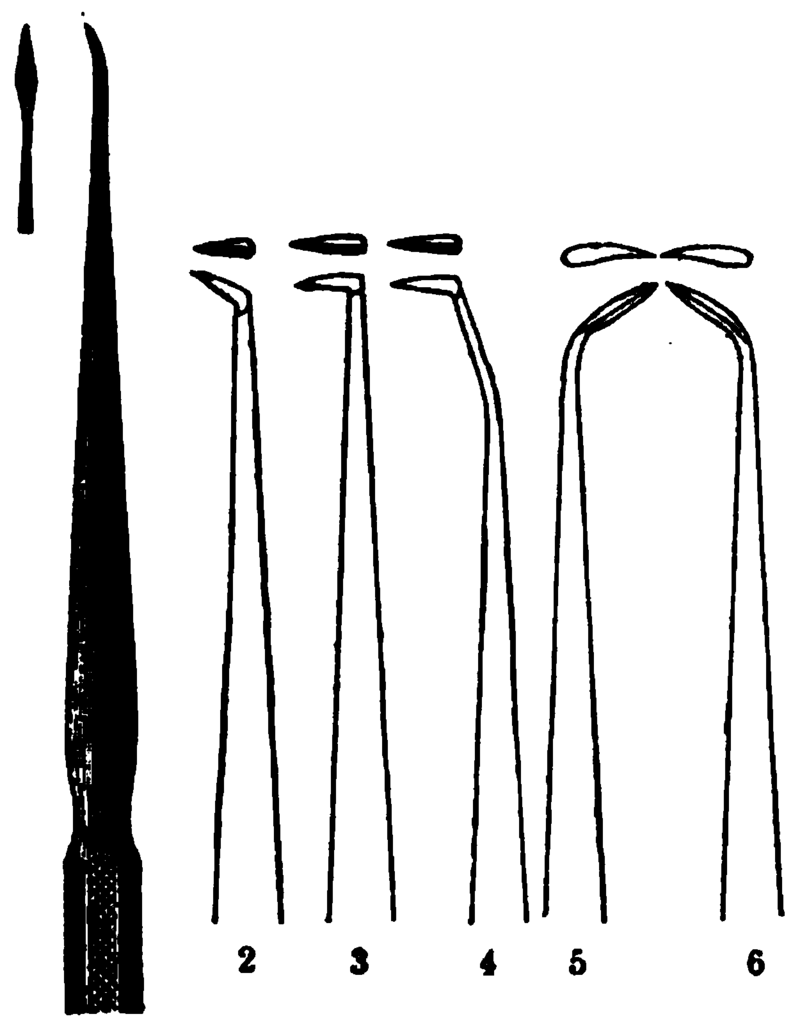

FIG. 6.

around and upon the teeth. For this purpose my scalers, Fig. 6, and spoon-shaped excavators, Fig. 7, are used. These deposits consist of tartar from the salivary glands at

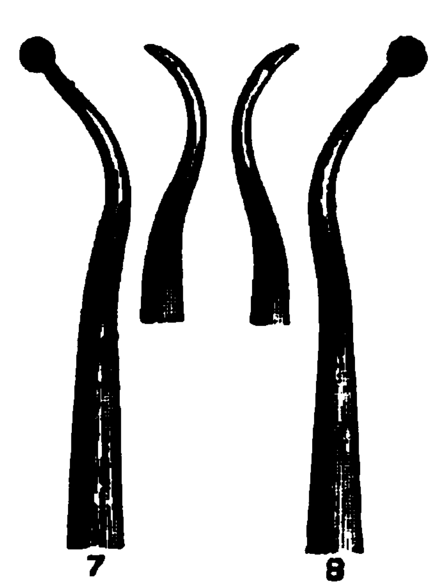

FIG. 7.

the necks of the teeth, calcic deposits upon the roots of the teeth. This deposit seems to be the absorbed alveolar process. The inflammatory state of the surrounding parts is such that

the circulation is impeded, wherefore the amorphous calcic salts of the alveolar process are deposited locally.

Encroachment of these salts upon the soft tissues causes irritation and inflammation. It prevents the fibrous structures from conrtacting tightly about the roots of the teeth. It causes debris and pus microbes to collect between the deposits and the inflamed tissue. The most satisfactory instruments for the removal of this deposit has been the spoon excavator. The shanks of these instruments may be bent at any angle. The spoon should be tempered very hard. They will thus keep a sharper edge. The deposit should be removed by drawing the instrument from the apex toward the crown. Inflammation is not confined to the peridental membrane. It extends throughout the alveolar process including the periosteum and mucous membrane. Hence blood letting is here indicated. The profession generally believes and states that no difference whether the disease be of local or constitutional origin, local treatment will cure. This is true to a certain extent. Blood letting (the more the better) will remove stagnation. Slight after treatment locally, will restore circulation. The tissues seemingly are restored to health. The cause, however, is still present in the system, wherefore temporary relief is only produced after the removal of all irritation about the necks and roots of the teeth aided by blood letting. Treatment as above recommended aided by change of climate, sea voyages, visits to springs with hot water baths and water drinking with plenty of rest will restore the patient to health.

The interstitial nature of this disease requires more than mere treatment of the peridental membrane. The gums, mucous membrane and alveolar process should be saturated with tincture iodine* every other day. This will reduce deep-seated

*Since its introduction in the treatment of interstitial gingivitis at the January 26th, 1896, meeting of the Academy of Stomatology, tincture iodine has come into general use. A quarter of a century's use has satisfied me this remedy is indicated by the pathology of this disease. Finding a more astringent preparation desirable, I devised a mixture of iodine, zinc iodide and glycerine. This has been given to the profession wherever I have lectured upon the subject of in-

inflammation throughout the alveolar process. Gum-massage brushes (hard and medium, never soft), should be used thrice daily.

I first advocated the vigorous use of the brush in 1886.† I found, however, the tooth-brushes on the market were not made properly for gum massage. After eight years of experimentation, while studying the etiology, I succeeded in producing a brush, Fig. 8, that gives fairly good satisfaction. The

Fig. 8.

results of this work was put in the form of a paper read at the International Medical Congress at Moscow, in 1897.

The old theory that a soft brush must be used because it made the gums bleed displayed ignorance both as to the etiology and treatment of this disease. It was found that the stiffest bristles were not too hard for the gums. When the bristles became moist the hardest softened. Two of the stiffest brushes are thus recommended, one used one day, the other the next. By so doing one has a chance to dry while the other is being

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terstitial gingivitis. The druggist cannot ordinarily get a clear mixture. Prof. C. N. S. Hallberg, of the University of Illinois, School of Pharmacy, after repeated efforts finally produced a clear solution, now prepared under the name of "Glycerole." This formula is as follows:

Zinc iodide	15.
Water	10.
Iodine	25.
Glycerine	50.

This will make about two fluid ounces. This explanation is necessary since certain teachers have given the formula without pointing out that as ordinarily made, extemporaneously, it is relatively valueless.

† *The Dental Cosmos,* page 689.

used. It is impossible to reach the gums in many places with the ordinary tooth-brush. Spaces are made in which the teeth may pass so that the bristles at the point may reach the festoons between the teeth in all parts of the mouth. The vigorous use of this brush together with the iodine will restore the alveolar process to a healthy action. It is a mistaken notion that the tooth-brush causes gum recession. Gums will recede until good, hard, healthy bone structure is reached and then cease. There is always bone absorption with the inflammation.

The name "tooth-brush" is misleading. Properly made gum-massage brushes if properly used, will at the same time do all the cleansing the teeth require.

An alkaline tooth-powder should be used. Mouth-washes defeat the object for which they are intended. The patient places in the mouth the wash and because it is liquid, swashes it about. The end is not obtained because it does not reach the parts involved. Vegetol powder recommended by Dr. M. H. Fletcher, of Cincinnati, Ohio, is composed of corn meal 75 per cent, potassium chlorate 5 per cent, and sodium borate 20 per cent, menthol and saccharin q. s. This is to be rubbed into the gums with the gum-massage brush. The corn meal will cleanse the teeth. Sodium borate will neutralize the acids about the gums and teeth. Potassium chlorate will contract the tissues about the teeth. The powder is to be carried into the mouth dry. Flow of saliva will dissolve it. The tooth-powder and gum-massage brush used twice or thrice daily keeps the mouth in a healthy condition.

Pus infection or pyorrhœa alveolaris is a terminal stage of the inflammatory action. The inflammatory action may continue and exfoliation of the teeth result without pus infection. In such cases the mouth is perfectly free from pus germs. Pus germs are most frequently found in the mouth. When such is the case, infection must ensue. It has been shown that the inflammatory process must be present for the parts to become infected. Reduce the inflammatory condition and pus infection ceases. Saturating the gums with iodine aided by the use of the gum-massage brush as already suggested will restore the

parts in most cases to health. It is useless to treat pus infection first. After the gums and alveolar process have been restored to health, should pus still flow from the alveolar process, deposits are still about the roots of the teeth. After these have been removed, mild antiseptic dressing such as oil of cassia, oil of cloves to the pus surface is all that is required. Tonics are sometimes indicated. A germicide mouth-wash should be used from the commencement of the treatment.

CONCLUSIONS.

I. Pyorrhœa alveolaris is the result of a previous inflammation, interstitial gingivitis.

II. Inflammation is due to local and constitutional causes.

III. The local causes are always local irritation.

IV. The constitutional causes are 1st., those due to auto-intoxication, 2nd., those due to drug poisoning.

V. When inflammation is present, absorption of the alveolar process takes place.

VI. The deposits upon the roots of the teeth is the absorbed alveolar process.

VII. Pus infection follows the inflammation.

VIII. The treatment consists in removing the cause.

IX. If due to local irritation, that irritation must be removed.

X. If due to auto-intoxication or drug poisoning, the poison must be eliminated through the excretory organs.

XI. If the auto-intoxication is due to disease, that disease must be eradicated.

XII. Since the urine is nearly always acid in these cases, an examination of the morning urine is always indicated before undertaking treatment.

XIII. Turkish baths, massuer treatment of the liver, skin, and peripheral nerves must be resorted too.

XIV. Since the system excretes forty ounces of water daily, eight or ten glasses should be used.

XV. Blood letting of the gums should be resorted to.

XVI. After which tincture of iodine should be applied every other day.

XVII. Gum-massage brushes, hard or medium (never soft) should be used three times per day. Restoring inflamed tissues to health will thus prevent pus infection.

XVIII. Should pus infection still persist in certain localities, oil of cassia or oil of cloves applied direct to the infected surface is indicated.

XIX. Change of climate and food together with tonics may also be used.—*From The Dental Summary.*

THE FRANKLIN PRINTING & ENGRAVING CO., TOLEDO.

Interstitial Gingivitis or Scorbutus

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D.,
CHICAGO.

Reprint from *The Dental Era*,
October 1905

Interstitial Gingivitis or Scorbutus.

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D., CHICAGO.

A discussion before the British Epidemiological Society, February 19, 1904, while seeming to involve the issue of treatment and prophylaxis, really involved the issue of diagnosis. This issue is likely to be frequently raised since the American acquisition of colonial possessions, requiring garrisons, and since the acquirement of the protectorate over the Panama canal.

Mayer Coplans, of the British army medical service, found that scurvy appeared among a population which had been maintained on government rations of good quality. This population consisted of burghers in "concentration camps," European soldiers, natives attached to the British army and to the civilian repatriation department.

Each concentration camp contained about 5,000 persons, forty-eight per cent being children under 12 years of age, and among adults the women were to the men as three to one. Inclosed by barbed wire, the camps, though open and airy, were securely isolated. The conditions being identical, the varying incidence of scurvy was remarkable. Between March, 1901, and January, 1903, with no cases at Standerton or Volksrust, there were one hundred Europeans and one native attacked. Among the soldiers at Standerton and the 22,000 European patients admitted to the hospital there was but one; among the natives in the service of the troops there were attacked 32 per cent of 400 muleteers, 22 per cent of those attached to the Hussars and the Royal Artillery, 87 per cent of the scavengers engaged in removing carcasses of animals, 17 per cent of the porters and about 50 per cent of the muleteers in the employ of the repatriation department.

The heaviest incidence of scurvy was after the close of the war and when all restrictions on food had been removed. In fact, it had no relation whatever to the food, but was almost everywhere directly in proportion to the neglect of cleanliness, of which the

natives had not the most rudimentary notions, especially as regards the hygiene of the mouth. Even the outbreak among the burghers at Middleburg followed overcrowding and neglect of sanitation. As to treatment, the food, though mostly preserved and tinned, was good, but many refused the harsh, sour lime-juice. Dietetic treatment was very successful—rapidly so if accompanied by mechanical cleaning of the teeth and gums, with continued use of antiseptic washes, though more slowly without.

A. E. Wright said filthy habits were not peculiar to the Kaffirs, and were not always accompanied by scurvy, which occurred in the nurseries of the rich and in nursing homes. Scurvy was essentially an acid intoxication, a reduction in the alkalinity of the blood, which could be observed long before the grosser manifestations, alike in the adult and infantile forms. A large proportion of the troops returning from South Africa were scorbutic in the latent stage.

R. H. Hirth called attention to the low values of the dietaries given, few exceeding two thousand kilocalories, or barely enough for the body work. The ash of tinned milk was often acid instead of alkaline. In one expedition he had had to condemn 30 per cent of the milk. A large proportion of British troops on return from "little wars" were more or less scorbutic.

J. Land Notter said the Kaffirs, though supplied with good food, preferred putrid meat or entrails of dead animals.

K. B. Goadby had not seen any scurvy at the Dreadnaught Hospital, but had met much pyorrhea alveolaris, a disease endemic and occasionally epidemic in West and Central Africa, the Transkei, the Philippines and other places. This condition of the gums, and the rapid recovery of the patients under antiseptic measures, resembled that found in scurvy.

H. T. Bulstrode called attention to the fact that the great naval surgeon, Lind, had, one hundred and fifty years ago, rejected the belief in specific action of lime-juice.

E. F. Willoughby was surprised at the absence of reference to the theory of Tonk, of Christiania, namely, that scurvy was no more nor less than a chronic ptomain poisoning, which he considered the only one that explained all the phenomena of scorbutus.

Polar expeditions led to the conclusion that a diet of fresh—even raw—meat, without any fruit or vegetables whatever, and associated with hardship, dirt and misery, or one consisting

entirely of tinned, preserved and sterilized foods of the highest quality but with no fresh food, animal or vegetable, did not produce symptoms of scurvy, while scurvy appeared when, along with potatoes, etc., and daily doses of lime-juice, the bulk of the food consisted of ordinary salt beef or pork. Until the recent antarctic expedition, from that of Nordenskjold in the Vega none had been attacked by scurvy except that of Jackson, whose men remained on board the ship, where they had lime-juice, potatoes, etc., but refused the coarse, even "gamy," bear's flesh, on which alone the exploring party subsisted. All were attacked with scurvy, two, indeed, dying.

The Laplanders of Finland bartered for farinacea, etc., but ate their fish putrid by preference, and suffered much from scurvy. Coplans pointed out in reply that it required months for its development, for the members of the corps that suffered most were recruited in their homes in October and the corps was dissolved in December, the disease breaking out soon after arrival in camp. Recovery followed rapidly on purely local treatment in the way of buccal antiseptics without any attempt to influence the blood.

The term "scurvy," frequently employed in the discussion, is applied to the disease in the mouth, especially in relation to the gums. Nothing is said in regard to other symptoms, and the logical inference is that such were not present.

In scurvy there is inflammation and bleeding gums; the gums puff up, thicken and bleed easily; the teeth become loose and sore upon mastication; a disagreeable odor comes from the mouth; salivation or ptyalism results from irritation from the teeth, as well as scorbutic anemia; the patient is languid or tires, perspires freely upon exertion, has shortness of breath and palpitation of the heart; the face is ashy gray, becoming paler each day; hemorrhage takes place in different parts of the body, especially beneath the skin, in the muscles and beneath the periosteum, as well as in the joints. This often gives considerable pain and sometimes causes inflammation, with resultant pus infection. Occasionally hemorrhage takes place in the internal structures. The temperature varies and both febrile apyretic states occur.

The symptoms observed in interstitial gingivitis are connected with the gums and alveolar process. There are no constitutional symptoms. This disease was formerly known as pyorrhea alveolaris because the disease was not recognized until pus was observed

about the teeth. It exists for years before pus is noticed. All the teeth may be lost without pus. Since the inflammation is deep-seated in the alveolar process as well as in the gums, I have designated the disease interstitial gingivitis. The interstitial gingivitis due to scurvy, drug or self-poisoning has the same pathology.

As part of the pathology, the character of the structures involved must be taken into account. In man's evolution, the face, jaws and teeth are diminishing for the benefit of the brain, under the law of economy of growth resultant on the struggle for existence between organs. Jaw recession is well illustrated in the American negro.

In man's evolution from the lower vertebrates he has acquired two sets of teeth. Some of the lower vertebrates possess continuous sets. These are used for awhile, shed, and new ones take their place. Man sheds the temporary set early in life. Should he live long enough the permanent set must be shed. This result is brought about by a process which takes place in the jaws of every individual, and has been designated osteomalacia or senile absorption.

Through the struggle for existence between organs and the eruption and shedding of the teeth, the alveolar process is a doubly transitory structure. Being an end organ, it is a most sensitive structure, easily affected by disease, drugs and faulty metabolism.

The age at which senile absorption begins depends upon the degree of normality of the individual. If he be neurotic or degenerate, or has inherited or acquired a cachexia or taint, this process of inflammation and absorption commences as early as the eighteenth or twentieth year. The process of shedding the temporary teeth and the eruption of the permanent teeth is a similar one, but the alveolar process holding the permanent set of teeth has not developed.

Interstitial gingivitis attacks every alveolar process after it has its growth, or about the twenty-sixth year. The severity depends entirely upon the degree of balance between the organs, including proper elimination.

At forty to forty-five, the fourth period of stress or period of evolution, the disease is quite active. From this time absorption is rapid, and loosening of the teeth later occurs, even in comparatively healthy individuals. If the patient be constipated, has kidney lesions, skin or lung disease, so that any one of the eliminating organs is not doing the work, autointoxication results; the inflam-

mation of the alveolar process is markedly increased. Other than improper elimination, no morbid condition will produce interstitial gingivitis as surely as intestinal fermentations. Through want of proper secretion, starchy food is not properly digested and fermentation results; gases accumulate in the intestines; the urine is excessively acid; indicanuria is present, with low specific gravity, and urea is scantily excreted. None of these symptoms are severe, but merely render the patient uncomfortable. The physician rarely considers them of moment. They play havoc, however, as a result of autointoxication.

Autointoxication due to faulty metabolism, changes in climate and surroundings, causing a want of proper adjustment of the excretory organs, no doubt produce the type of interstitial gingivitis before designated as "scurvy." The same results have appeared with the American soldiers in Cuba and the Philippines, and with engineers and workmen building railroads in high altitutes in Switzerland. People going from a mild climate to an extremely hot or cold one, or *vice versa*, with or without change of food, do not readily adjust themselves to the new environment, and the underlying states of interstitial gingivitis develop. Hygiene in Panama will be needed along these lines, since interstitial gingivitis increases very disastrously the morbid conditions to which, in part, it owes its origin.

Constitutional secondary consequences of interstitial gingivitis could, as Goadby evidently surmised, mimic scurvy, even as to the hemorrhages, and here antiscorbutic treatment would be useless. It must be remembered that depression plays a part in this direction through its influence on elimination and alimentation. The defective metabolism of the insane, independent of diet, produces hemorrhagic states. The first test of all these states is the gums, and here treatment, with proper stimulus of elimination, will aid assimilation and remove these "scorbutic" tendencies.

ENDARTERITIS OBLITERANS AND ARTERIAL HYPERTROPHY IN THE ALVEOLAR PROCESS

BY

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Reprint From October DENTAL DIGEST.

ENDARTERITIS OBLITERANS AND ARTERIAL HYPERTROPHY IN THE ALVEOLAR PROCESS.

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Endarteritis obliterans and hypertrophy of the middle and outer coats of arteries are a physiologic process concerned in the disappearance of blood vessels functional in the fetal state but losing such function after birth. Like all physiologic processes of a fetal type it becomes pathologic under the ordinary conditions of post-natal life. For these reasons it again becomes physiologic in the involutional periods like the climacteric and senility. In transitory structures the process is therefore continually trembling between physiologic and pathologic. Undue excitation of the structure brings on an intensity of the process which tends to become pathologic. As I demonstrated nearly half a decade ago, endarteritis obliterans and hypertrophy of the middle and outer coats of arteries play a large part in interstitial gingivitis or so-called pyorrhea alveolaris.

The pathogeny of this process was first discussed at length in 1876, yet but little has been contributed to the subject since. For this reason I have collated the literature which is herewith given before my own experience.

Cornil and Ranvier found the small vessels embedded in inflamed tissues shared in their inflammation and endarteritis. Obliteration of the lumen was a fréquent occurrence in these conditions. In their opinion, obliteration of vessels in tuberculosis was effected by pressure on the vessel, causing slowing of the blood stream and ultimately thrombosis, the thrombus later becoming organized. (Manual d'Histologie Pathologique, 1869-73, page 555.)

Heubner, who in 1874 described in detail occurrence of primary disease of the cerebral arteries, maintains that affection commences in

the intima and is essentially a gummatous growth starting thence. The endarterital growth undergoes incomplete organization, imitating the structure of the normal arterial coats and being to some extent differentiated into an intima composed of embryonic connective tissue and a muscularis formed of large spindle-cells running transversely, the two layers being divided by a brightly refracting line of elastic tissue, representing the elastic lamina. The newly-formed imperfect elastic layer can be easily seen in many specimens in which the growth has become fairly organized. (Die Luetische Erkrankung der Hirnarterien, Leipzig, 1874.)

Friedlander in 1876 called attention to an affection of the arteries of which little previously was known which he termed arteritis obliterans. It was characterized by the development of cellular connective tissue within the intima of the medium and smaller arteries

Fig. 1. A—Adventitia E—Elastic Tissue Between Middle Coat and Intima. M—Muscular. J—Thickened Intima.

which leads to contraction and obliteration. The process begins with a proliferation of closely compressed round cells between the innermost elastic lamella and the endothelium. The cells enlarge, an intercellular substance develops, and the tissue appears to have the character of the granular tissue as also of the mucous tissue, although without mucin reaction; new vessels likewise often form little arteries with abundant circular fibres of the ciliary muscle. The proliferation makes its appearance either circumscribed or concentric around the vessel periphery, whereby either partial or local contraction and obliteration take place. The newly developed tissue retains for a long time the appearance of the granulation tissue, or passes into a dense sclerotic connective tissue, or becomes caseous; fatty or calcareous degeneration, as in atheromatous process, is the exception. Under these conditions the remaining elements of the wall of a

vessel undergo manifold changes. Arteritis obliterans seldom occurs primarily. Under physiologic conditions it causes occlusion of the ductus arteriosus of the umbilical artery and of the arteries and veins of the uterus post partum. As a secondary process, on the contrary, it has a wide range.

Heubner's syphilitic disease of the cerebral vessels belongs to this category and has no specific syphilitic character as Heubner believed. It occurs in meningitis, neoplasms, abscess processes, tuber-

Fig. 2. Cross-Section of Peridental Membrane, Showing Endarteritis Obliterans. Scurvy in Man. C—Cementum. D—Dentin. I—Peridental Membrane. U—Nerve Tissue. EO—Endarteritis Obliterans.

culosis of the lungs, lobular and interstitial pneumonia, inflammations of the small bronchi and of the lactal ducts in cancer of the mammary glands and in all chronic inflammation. The pathologic changes of the arterial surrounding set forth in the wall of the vessel and produce arteritis. By experiments on animals affected with tubercular diseases and in lung affections by cutting through the un. laryngei inferiores the changes have been plainly recognized

after forty hours. The cellular element has probably three origins—either it is a production of the endothelium of the vessels, or it is from white blood corpuscles that originate in the arterial blood, penetrating between the endothelium or from the vaso vasorum. The last named plays, in Friedlander's opinion, the principal role. Corresponding to the proliferation of the intima accumulations of

Fig 3. Longitudinal Section of Gingival Border, Higher Magnification, Showing Round-Cell Inflammation Extending to the Inner Coat of the Blood Vessel, and also Plasma—Mast Cells.

cells were always found in the adventitia. (Cent. f. d. Med. Wissen, Berlin, 1876, vol. 14, page 65.)

Zeissl (Wien Med. Blätter, 1879, vol. 11, page 562) reported a case of obliteration of the left brachial artery caused by leutic endarteritis in a thirty-seven-year-old male who had acute articular rheumatism, and ten years previously syphilis which twelve weekly treatments were supposed to have cured. For two years a tumor gradually developed in the upper part of the left arm. For two

months the tumor caused severe pain, strength and flesh lessened, and the tumor appeared cooler than the rest of the arm. The patient was anemic, the radial pulse weak. After treatment for fifteen weeks the tumor diminished to a very slight swelling. The artery was completely obliterated and later collateral circulation established itself. After five months the swelling entirely disappeared.

W. B. Hadden reports the case of a thirty-five-year-old woman who six months previous to consultation had severe pain in right arm shooting down the hand. Four months later the tips of the first and second fingers became hard and cracked. She was healthy, well nourished and had no visceral disease. She complained of constant

pain, occasionally shooting into the thumb and first and second fingers of right hand. The fingers were pale and cold and on the tips were flat irregular warts. The thumb was pale, cold and stiff, the tips hard and thick. There was no pulsation in the radial and ulnar arteries, but it existed in the arteries at the bend of the elbow. Tenderness was present along the whole brachial. The skin over the ends of the thumb and the first three fingers became gangrenous and sloughed. According to Hadden the prolonged pressure on the arteries was the exciting cause. (Tr. Clin. Soc. London, 1884, vol. 17, page 105.)

According to Hippolyte Martin the internal tunics of most of the small arteries are subject during practically man's whole life to irritating influences which inflame and thicken them and consecu-

tively diminish blood in the circulation. Progressive obliterating endarteritis begins in infancy and is localized then, especially in nutritive vessels of the first portion of the aorta; hence the minute atheromatous patches on its surface. Later it invades numerous small arteries, but is localized particularly in the circulatory and active functional organs. Progressive diminution in carrying nutrition destined for viscera entails simultaneously atrophy of functional elements and proportionate development of connective tissue. This sclerosis starts practically from an affected arterial trunk, where nutrition is most markedly insufficient, it is not preceded by capillary lesion on this surface. The functional cellules in the vicinity of its origin appear healthy and are not inflamed during the initial period and until sclerotic tissue has perceptibly developed. These according to Martin do not result from inflammatory irritation, hence he has designated the condition dystrophic sclerosis. Progressive endarteritis may occur in acute form, especially in infectious diseases (diphtheria, typhoid fever), and then entails rapid circulatory disturbances which may cause death, when the organ affected has a function as important as that of the heart. Irritant elements circulating in the blood, especially of certain individuals (alcoholic, saturnine, gouty, etc.), exaggerate and hasten evolution of chronic progressive endarteritis. From a histologic point of view, proliferation often starts in the terminal artery itself, and there remains localized or extends beyond it. Sometimes, however, it predominates beyond the internal elastic bandelet, separating same, and in these cases the morbid processes should be seized from the first phases in order to comprehend the point of departure, the localization and evolution. (Revue de Medicine, 1881, vol. 1, page 32.)

Robert Saundby, discussing endarteritis and the inflammatory changes in the coats of the small vessels, agrees with Friedlander, Baumgarten and others that this affection is a non-specific endarteritis, the sequel to gummatous infiltration of the adventitia. It is not claimed by either side that the endarterital lesion presents any characteristics by which its specific nature can be positively identified, and the whole dispute therefore turns on the seat of the initial lesion. Saundby asserts he never saw a case of arterial syphilis in which there was not marked infiltration of the adventitia and never knew of a case in which this had not been present. (Journal of Anatomy, 1882-83, vol. 17, page 180.)

Alfred Will describes gangrene on both upper extremities following endarteritis obliterans in a fifty-two-year-old man, who after a railroad accident from which he sustained great shock lost strength gradually. One day he noticed the sudden development of gangrene on the middle finger of the left hand; later an abscess the size of a walnut appeared on the medial side of the left upper arm; then the middle finger of the right hand was observed to discolor, and there was much pain in the arm and hand. Patient died five weeks after

Fig. 5. Transverse Section of Alveolar Process, Chronic Inflammation Extending throughout. Dog. N—Large space Arising from Absorption of the Alveolar Process starting in the Haversian Canals. EO—Endarteritis Obliterans..

the gangrene had developed on both arms, and the autopsy led to the diagnosis of endarteritis. (Berlin Klin. Wochen., 1886, vol. 23, page 268.)

Hatch describes obliterative endarteritis in a male aged sixteen whose right little toe became blackened, ulcerated and dropped off. He attributed this to exposure to damp while working in rice fields.

Subsequently the other bones of that foot became similarly affected and separated from the metatarsal bones. There was no history of any previous disease. Operation was followed by tetanus, transfusion and death. Hatch remarks that under the low state of vitality induced by insufficient nourishment, obliterative arteritis followed by dry gangrene is not uncommon among the poor of Bombay. (Lancet, vol. 11, 1895, page 16.)

Pearce Gould relates a case of spreading and obliterative arteritis in a nineteen-year-old man with no family or personal history or evidence of syphilis, and the following symptoms. The right hand and forearm were colder than the left and somewhat wasted. When the hand was warm he could wash with it, but it quickly became cold and painful, and was always worse at night. The brachial

artery was harder than the left and less affected by the pulse, which ceased in it just above the elbow joint. The radial artery was felt as a prominent hard pulseless cord. There was no pulse in the ulnar artery, and all other arteries appeared normal. There was a small patch of dry gangrene on each of the first, third and fourth digits. Temperature and urine were normal. Gould lays the most stress

on the small amount of gangrene that resulted from so extensive an obliteration of the main arteries of the part. This case resembles Raynaud's disease.

Mahomed observed a case of obliterative arteritis which terminated fatally. The patient, a man, suffered from attacks of pain down one arm, accompanied by angina pectoris. Thrill and *bruit* were distinguished in the subclavian artery and aneurism was suggested

as a cause. Necropsy revealed the arteritis. (British Medical Journal, 1884, vol. 1, page 317.)

George L. Peabody in 1886, reporting four cases of endarteritis obliterans to the New York Practitioner's Society, said: "It is interesting that death may result from this lesion with striking clinical evidences of destruction of motor areas in the brain, which autopsy reveals to be intact."

In addition to the partial obliteration of the lumen of the nutrient artery of the area affected there must be spasmodic contraction of the vessel or vessels, sufficient to cause complete local arrest of the circulation. This contraction varies; it may last a few minutes or may be prolonged until death ensues. Another possible termination is hemorrhage. This is frequently found in nearly all the organs of the body. Peabody observed it in the lungs, kidneys, heart and in neoplasms, especially in epitheliomata, and more particularly in the brain. Peabody does not believe that it is due to syphilis, as held by Steinberg, Heubner, Wilks and others. His four cases are as follows:

Case I. An Irish tailor, aged fifty-six, denied syphilis, temperate habits, suffered for six months from continuous headache and ringing in the ears. Ten days previously he fell to the floor unable to move either right extremity, speechless but conscious. Half an hour later he was able to talk and power returned to the leg but less to the arm. He had several attacks of similar character since the first one mentioned. Could not speak or move but generally recovered in a few minutes. He was senile, superficial arteries stiffened and tortuous, poorly nourished, and had incomplete right facial paralysis, well-marked right hemiparesis, lateral curvature of the spine, chest barrel-shaped, heart sounds normal. Death ten days later. Post-mortem showed pathologic changes in the Circle of Willis, showing insignificant patches of atheroma. Microscopic examination of the arteries exhibited the lesions to be chronic endarteritis. A connective tissue growth from the intima involved to a varying degree almost the entire circumference of the vessel.

Case II. Stenographer, aged thirty-six, for several weeks prior to illness complained of vague and indefinite pains in the occipital region and of sharp lancinating pains on right side of head. After working steadily all day and evening he retired about eleven, and at one o'clock next morning his wife became aroused by loud stertor-

ous breathing. She failed to rouse him to consciousness, and he was wildly delirious, endeavoring to force his way through the wall. Later he became profoundly comatose. From this condition he was never again aroused. When loudly spoken to and shaken his face would become distorted as if in pain and he would bring his right hand to his head and groan. Urine suppressed for twenty-four hours and then fairly abundant and of normal characteristics. Marked cutaneous hyperesthesia but never any paralysis. Death forty-five hours after commencement of attack. The patient believed himself

syphilitic, but attending physician was never satisfied that he was. Microscopic examination of the basilar artery at the site of the lesion revealed combined the evidence of well-marked periarteritis and endarteritis obliterans. The wall of the basilar artery was very thick, owing to a growth from the intima.

Case III. Woman, aged eighty, history of sudden unconsciousness continuing for a week. Complete paralysis of the left arm, incomplete paralysis of left leg. The extremities of right side were rigid, automatic movements of right hand and arm, imperceptible pulse. Death followed twenty-six hours later. Autopsy showed

the cortex of the brain to be in condition of senile atrophy, the vessels at the base of the brain and the two middle cerebral arteries extending well into the fissures of Sylvius, showing condition of obliterating arteritis.

Case IV. Watchman, aged forty-five, suddenly attacked with convulsions, more marked on right side. Sufferer from rheumatism, headache, dyspnea on excretion, poorly nourished. Superficial arteries rigid and tortuous, rigidity and occasionally convulsive movements of left extremities, slight right facial paralysis. Arcus senilis was marked, complete amnesic aphasia. After two weeks he left the hospital apparently well. The course of his disease precluded syphilitic pachymeningitis.

Weinwarter found in a foot, amputated by Billroth because of spontaneous gangrene, a peculiar endarteritis and endophlebitis, which greatly differed from atheroma. Through a proliferation of the intima the lumina were partly obliterated, partly constricted. Weinwarter found no vein wholly obliterated. In his opinion exposure to cold and moist clothing extending over a period of years may eventually provoke a chronic process of proliferation in the vessels, since his patient on account of susceptible frost bite frequently bathed the parts with snow. (Arch. f. Klin. Chir., Bd. 23, page 202.)

W. J. Walsham describes acute obliterative endarteritis in a man aged fifty-two. There was no history of syphilis or alcoholism and no cause could be assigned. The right arm was affected. The disease spread from below upward (while the patient was under observation) reaching as high as an inch below the clavicle. Furthermore there was the same indurated, tender and pulseless condition of the radial, ulnar, brachial and lower portion of the axillary arteries as the sub-clavicle artery formed an aneurysmoid swelling the size of a hen's egg. The hand and forearm were cold and tips of fingers cold and bloodless. There was intense pain in hand and forearm, and the disease after lasting about four months subsided spontaneously. Walsham believes that the disease depends upon nerve lesion. (Lancet, 1888, vol. 1, page 571.)

Walter Pye reports a case of obliterative arteries in a man who had to use a crutch since eight years of age. There was loss of sensation in the fingers, and ultimately the artery from the axilla downwards solidified. Circulation returned to some slight extent. In discus-

sion of the case Hadden said it resembled a class of cases in which plastic effusion into the arteries gives rise to thrombosis. (Lancet, 1888, vol. 1, page 699.)

Bertram W. Bond reports obliterative arteritis in a boy aged fourteen who had an attack of "shingles" on the left side of the chest and back. No pulse could be felt in the upper extremity of the left subclavian. Here the beat was synchronous with that of the right subclavian but much feebler. The pulse in the right radial was normal and no undue thickening of arterial walls could be felt. The radial and brachial arteries felt as cord-like bodies. The boy complained of the "pins and needles" sensation. His collateral circulation was good. Beyond slight blueness of the fingers there was no visible sign of deficient nutrition, and there was no history of rheumatism or congenital syphilis. (Lancet, 1895, vol. 1, page 150.)

Dutil and Lamy report a case of endarteritis obliterans similar to that of Friedlander. They state that the affection is precocious, is seen principally in the male, makes its appearance independent of atheroma, with no syphilitic or alcoholic diathesis. The small arteries of the nerves are inflamed, even obliterated, corresponding degenerative neuritis ensues, having a proportionate development

to the vascular lesion. To these two groups of alterations important phenomena are attached. One is the intermittent claudication and painful sense of helplessness which develops during walking but ceases quickly with absolute rest, and the other is an ensemble of gangrenous alterations where neuritis and vascular obliterations intervene at the same time. (Archives de Med. exp. vol. 5, page 1, 1893.)

Borchard reports six cases of primary endarteritis obliterans that occurred in the surgical clinic of Konigsberg. They came under observation as cases of spontaneous gangrene of the lower and upper extremities, and on account of the relative youth of the patients and the peculiarly slow progress particular observation was made which resulted in the above diagnosis. In all six cases there was a more or less complete obliteration of the arteries by an obturative mass which consisted of glistening connective tissue and spindle-shaped or oval endothelium-like cells. The latter are not uniform, but are divided into closely compressed groups. The numerous vessels are especially rich in cells. The walls consist usually of a layer of endothelium, singular, circularly-arranged muscular layers. To this are added in somewhat rarer cases a more or less strong adventitia and in the intima one or more distinct elastic membranes. In the open vascular layers fresh red-blood corpuscles can be recognized. Abundant old and young blood pigment is found in the middle and then on the edge. Next to singular, thin-walled newly-formed vessels, traces of hemorrhage can be recognized at a remote distance. On the outside this innermost peculiarly obturate mass is surrounded by a homogeneous layer with few cells which follows every sinus and fold of the winding and extraordinarily glistening elastica. Occasionally more than four layers of these elastic fibers may be recognized, all of which course parallel with the peculiar membrane. (Deut. Zeitschr. f. Chir., 1896, vol. 44, page 131. Illustrations.)

Hoegerstedt and Nemser in an elaborate article upon the constriction and closure of large arteries give an account of three cases. Syphilis appears to have been the principal etiologic factor, in others arterio-sclerosis with or without syphilis and strain. In these cases a number of large arteries of the trunk and limbs have been constricted and even gradually occluded and converted into fibrous cords. It began with thickening of the arterial wall in the form of

arterio-sclerosis or as a syphilitic endarteritis, and it terminated in thrombosis and occlusion. The symptoms varied according to the arteries affected and the rapidity of the process of occlusion; where it was gradual the collateral circulation was established and there was no functional defect. (Zeit. f. Klin. Med., 1896-97, vol. 31, page 130.)

Thoma does not agree with Friedlander that there is a special form of obliterative endarteritis, neither is he of the opinion of Billroth and Weinwarter that gangrene in both old and young subjects is due to this condition. He believes that the above authors have mistaken for it a thrombus replaced by connective tissue occurring in an artery affected with arterio-sclerosis. (Text-book of General Pathology, vol. 1, trans. by Dr. A. Bruse, 1896.)

Walter G. Spencer says with regard to the occurrence of arteritis obliterans in the arteries of the limbs, the term is not here used as synonymous with obstruction such as may occur from embolism, thrombosis, atheroma or calcareous arterio-sclerosis. It is also clearly distinguished from gangrene following Raynaud's symptoms. Confining attention to arteritis obliterans proper, we have the cases described by Weinwarter and by Widemann occurring in old patients in which there was undoubted thickening of the intima, yet owing to the age of the patients and their other complications one may doubt whether the cases were not allied to more familiar forms of arterial disease. Spencer's case—male, aged twenty-seven, mother and two brothers died of phthisis and a sister was subject to it. The

patient's left foot was cold at times and he had to rub it to get it warm. A sore formed on the toe, healed, and broke down again. Three weeks prior to admission to hospital left foot changed color to bluish red and a dark spot formed on the great toe. At night the left foot became painful across the base of the toes, pain over the upper course of the anterior tibial artery on the left leg and foot, dusky red patch of gangrene would not disappear on finger pressure. No pulsation could be felt in the left leg. A cord occupied the line of the femoral artery. The right leg and foot were also cold, but had good color excepting for the blue black patches which did not disappear on pressure, no pulsation. No pulsation over the abdominal aorta and iliacs. The right arm was colder than the left. Subclavical, axillary and brachial arteries were smaller on the left side. The radial pulse was of low tension. (Clin. Soc. Trans., 1897-98, vol. 31, page 89.)

Allbutt (System of Medicine, 1899, vol. 7, p. 301) says that obliterative endarteritis was first described by Friedlander in 1876, that it is often accompanied by neuritis, and before complete obliteration intermittent claudation of the arteries of the limb may occur, associated with cyanosis and coldness of the extremities, thus giving rise to a condition resembling Raynaud's disease. The disease is more frequent in men than in women, and affects adults between thirty and sixty. Causes unknown; not associated with any particular diathesis, nor with any acquired disease such as syphilis, alcoholism, malaria, albuminuria or diabetes. Microscopic examination reveals thickening of the walls of the arteries due to cellular proliferation of the endarterium and hypertrophy of the middle and external coats, development of the vaso vasorum in the middle and external coats, and inflammatory thickening of the small vessels which may have led to complete occlusion. The obliteration of the lumen of the artery may be due to thrombosis or proliferating endarteritis. The coats of the veins may be thickened but these vessels are not blocked. The muscles of the limbs may degenerate while the nerves remain unaffected.

Any artery of the body is liable to become involved but more particularly in those of the extremities. While puberty may produce a severe attack, the condition is more frequently noticed later in life—the later the more pronounced. Men are more subject to the disease than women. Coldness of the limbs, hard whip-cord arteries

with no pulsation, and gangrene of the extremities result. The disease begins in the intima and extends to the other coats of the artery. It may be found in all local inflammations of long standing, especially in the extremities, and may occur in conditions of vaso-motor ataxia such as are present in Raynaud's disease and allied conditions. Syphilis, tuberculosis, typhoid fever, scurvy, and the condition underlying arterio-capillary fibrotic kidney lesions act at times as predisposing causes. Toxins and autotoxic products of retained waste may disturb physiologic balance, thus giving the pathologic phase this disorder sway. If the disease is more frequent in men than in women, it is because women eliminate much more freely than men, and because they are not often subjected to drug poisons.

Endarteritis is an inflammation of the intima or internal coat of the arteries and capillaries, generally of a chronic type. Other coats of the arteries may become involved in which there is also a thickening. Its pathogeny is as follows: In direct contact with the blood streams is the endothelium (a layer of flattened cells); next is the tunica intima, composed of elastic fibers arranged longitudinally; next comes the middle coat, composed of muscular fibers arranged transversely. The outer coat consists of longitudinal connective tissue, which contains the vaso vasorum. In the capillaries the intima lies in immediate contact with the surrounding tissues, or is accompanied by a rudimentary adventitia. In other words, the walls of the capillaries consist of almost nothing but the intima. The capillaries have certain contractility; they contract or dilate without muscular fibers. The veins probably also have a cer-

tain amount of contraction and dilation from irritability of the intima. Each coat of the arteries takes on a special type of inflammation. The causes of endarteritis are numerous. Inflammation of the intima of the blood vessels may be due to irritation from without or within.

When it occurs from without any local irritation will set up an inflammation which may extend to the outer coats of the capillaries. This produces a marked increase of blood. The vaso vasorum becomes swollen, the white blood corpuscles crowd into the terminal capillaries and migrate into the extravascular space. Rapid proliferation of the round-cell elements takes place. The walls of the vessels become thickened. Owing to the projecting intervals of the intima the caliber of the blood vessels diminishes. Fig. 1.

Irritation occurring from within results either from trophic changes in the system from direct irritation from toxemias or from both interdependently. Under these circumstances a germ disease or other toxins may have an affinity for a certain organ, tissue or part and produce irritation in the capillaries in a distinct part of the body, or the capillaries through the entire body may become involved. Thus in typhoid fever Peyer's glands in the intestine become involved; in scarlet fever, the skin or kidney; in malaria, the liver and spleen; in Bright's disease, the kidney; while in mercurial and lead poisoning and scurvy the mucous membrane and especially the gums become diseased. In many of these conditions, however, before the tissue already irritated becomes involved the nervous system may already have become affected from other causes, such as locomotor ataxia, traumatic injuries to the spine, paretic dementia, cerebral paralysis, neuroticism and degeneracy, and last but not least, stomach neurasthenia. The poison in the blood, together with the diseased peripheral nerves, produces irritation and inflammation of the inner coat of the capillaries. If this irritation does not disappear soon after its inception the inflammation tends to affect the other coats of the blood vessels. Under certain conditions, however, endarteritis may never involve the other coats of the vessels. When irritation of the inner coat of the capillaries takes place proliferation of the endothelium occurs. This inflammatory growth tends to obstruct the lumen of the vessel. The media may likewise become thickened by an increased connective tissue. The capillaries become obstructed and finally obliterated, which eventually impedes the circulation. Fig. 2 shows such a condition in a case of scurvy.

Irritation may be of less intensity but greater duration, as in syphilis, tuberculosis, scurvy, mercurialism, plumbism, etc., and the results are then slowly effected. Proliferation of subendothelial connective tissue gradually increases until it reaches its limit (endarteritis obliterans). This influence of the proliferation is exerted in addition to that of the round-cell infiltration about the structure.

The recent studies of Hektoen (American System of the Practice of Medicine, page 119) on meningeal tuberculosis demonstrate that tubercle bacilli may penetrate the unbroken endothelial layers of the vessel and stimulate proliferation of the subendothelial connective tissue. An internal irritant, such as may be produced in the course of any infectious disease or from suboxidation, probably acts upon the endothelium of the walls of the smaller blood vessels in such a way as to permit the escape through the walls first of serum, and then of leucocytes, the latter infecting and surrounding the vessels. The effect of the chronic endarteritis is to check the blood supply to the gum tissue. Mercury, lead and other poisons circulating through the blood are forced to remain, hence the discoloration of tissue along the gum margin. Interstitial gingivitis, resulting in a slow disturbance of nutrition, produces overgrowth of connective tissue. In all cases of chronic interstitial gingivitis, as shown in the illustration, are the blood vessels thus involved.

Among the predisposing influences which cause this disease are syphilis, tuberculosis, mercurialism, plumbism, brass poisoning, lithemia, nephritis, gout, rheumatism, alcoholism, scurvy, nervous diseases, pregnancy and old age. Under certain conditions of the system any and all diseases which tend to lower the vitality, producing anemia, will assist in producing this disease. The direct cause may be resultant overstrain of the blood vessels.

Owing to obliteration of the arteries in the alveolar process stasis of blood must follow. The detritus from the alveolar process must therefore remain in the tissue and collect upon the roots of the teeth.

What concerns the dentist more than anything else (and to which I have often called attention) is the fact that the alveolar process is a transitory structure and is hence susceptible to atrophy and disease. This is due to the fact that the structure is an end organ. The nerves and blood vessels approach a blank wall. The root of the tooth is virtually a foreign substance. The blood vessels and nerves concerned are also approximately end organs. My investigations

have been made upon human and animal alveolar processes which have suffered from almost every disease in which these tissues could become involved.

Endarteritis obliterans and hypertrophy of the blood-vessel walls in the alveolar process are always observed in connection with both local and constitutional causes.

On administration of drugs, especially mercury or lead, to healthy young dogs, inflammation of the alveolar process with diseased arterial walls is seen at the end of a month or six weeks. Fig. 3 shows the commencement of the thickening of the intima in a dog. The coats of the arteries are well defined, and the inflammatory process has just begun. Examination of the alveolar process of animals or human beings suffering from disease in which the eliminating organs are not throwing off effete matter, especially in syphilitic, tuberculous and scorbutic patients, easily reveals this morbid state.

Fig. 4 is a poor illustration of the disease in pregnancy. If such patients are degenerates the process will be exaggerated.

Fig. 5 illustrates endarteritis obliterans in the artery of a dog with interstitial gingivitis.

Fig. 6 is from the alveolar process of a tuberculous monkey.

Fig. 7 illustrates the closing of three arteries from mercurial poisoning.

Fig. 8 shows endarteritis obliterans with arterial-coat hypertrophy in interstitial gingivitis from lead poisoning.

Fig. 9 shows hypertrophy and endarteritis obliterans in interstitial gingivitis from diabetes mellitus.

Fig. 10 illustrates hypertrophy of three arteries in a syphilitic.

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PATHOGENY OF ROOT ABSORPTION AND ALVEOLAR ABSCESS.*

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Elsewhere I have demonstrated pathology of the alveolar process and teeth, separately from the viewpoint of the law of economy of growth or use and disuse of structures. The two in relation to each other under the operations of the same law now require attention. In evolution man is lessening jaws and teeth for the benefit of the brain. This is brought about by reduction in size or exclusion of teeth in the anterior and posterior part of the mouth (third molars and lateral incisors) and by rapid tooth decay. So unstable are the jaws and teeth that not infrequently other teeth—the central incisors, cuspids, bicuspids and molars, for instance—are checked in development. From atavism extra teeth develop. So unstable is the alveolar process that were man to live long enough he would lose his second set of teeth by osteomalacia or senile atrophy, then normal but in essence atavistic. Continuous shedding of teeth, as is done by some snakes, the elephant, etc., is an expression of osteomalacia. The widespread influence and operation of this process is shown in the lost teeth of birds, of the duck-bill and of the Greenland whale.

Absorption of the alveolar process is always resultant upon irritation and inflammation. The process being doubly transitory, and the nerves being end organs, the slightest irritation sets up inflammation. This may by erupting tooth, pressure in regulation, tooth-wedging for filling, or local or constitutional causes produce interstitial gingivitis.

Because of this instability, any irritation and inflammation upon the alveolar process may shed the teeth at any period of life. From this source came the destruction of the alveolar process by crowns

*Reprint from February, 1904, DENTAL DIGEST.

and bridgework, and the old methods of correction of irregularities

Absorption of tooth roots is a potent destructive element. Roots of teeth with dead pulps are absorbed more readily than those with live pulps. The process is that of systemic removal of foreign or partially foreign substances.

Three forms of absorption result from inflammation of the alveolar process—halisteresis, Volkmann's perforating canal, and the osteoclast or lacunar absorption. The first two are confined to the alveolar process, the last (osteoclast) affects both process and tooth

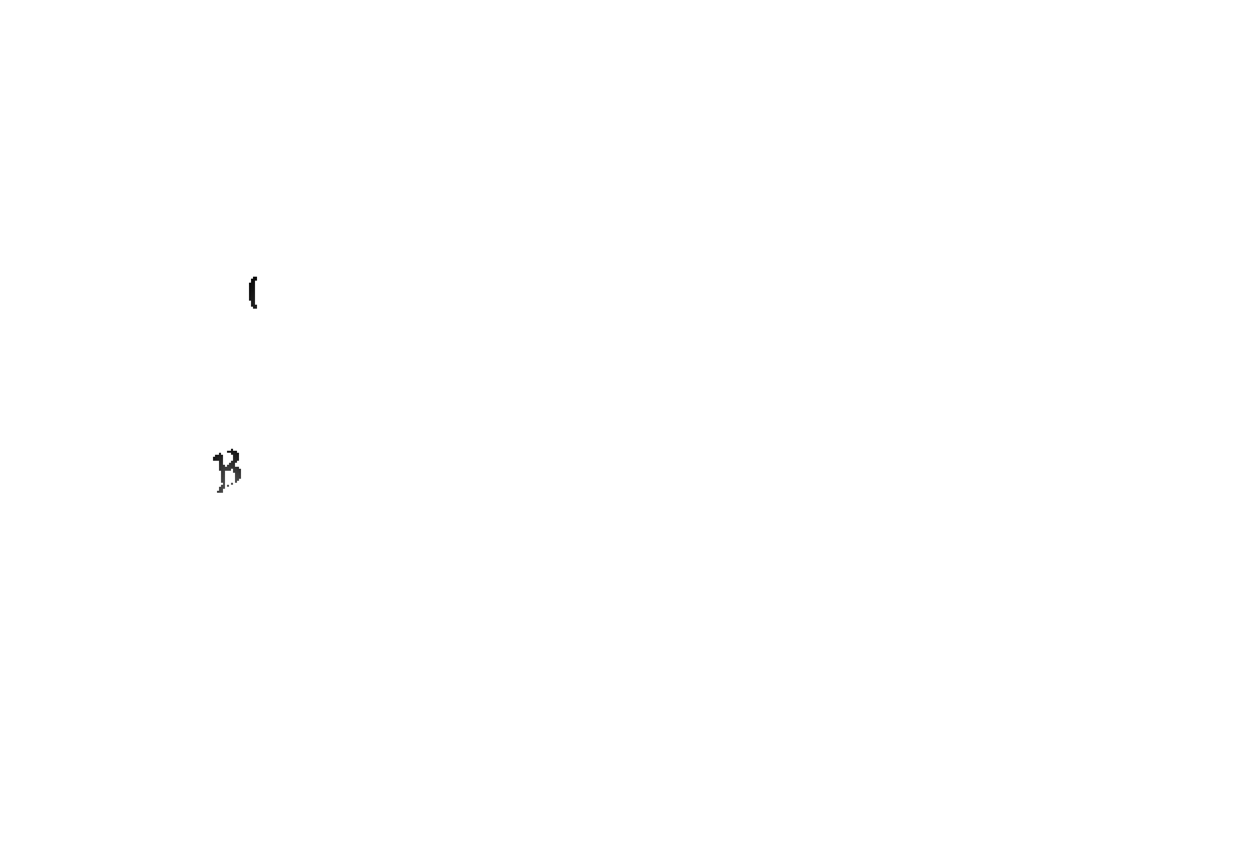

Fig. 1.

root. The three are active when round-cell inflammation is present Extracted or erupting teeth, irritation at the end of the root by putrescent gases or inflammation by injury thus cause absorption of the alveolar process. Osteoclast absorption may or may not result. When it does root absorption occurs. The location depends upon the center of inflammation and whether it be in contact with the root.

While absorption is said to be physiologic, it is not more so than all pathologic processes which are physiologic under certain conditions (fetal life, etc.), but under the conditions in which they

are found have a morbid element destructive of the parts concerned for the benefit of the body as a whole. Absorption is a pathologic or inflammatory condition, and round-cell infiltration is generally found in connection with absorption. The alveolar process is composed of lime salts or earthy substances and animal matter or the trabeculæ. The trabeculæ hold the lime salts in position. In inflammation the lime salts are removed by the three forms of absorption already mentioned, leaving the animal matter in position. If from any cause the trabeculæ be destroyed the osteoclasts have no support and absorption cannot take place.

FIG 2

When a permanent tooth begins to erupt resultant irritation causes inflammation in the surrounding alveolar process, resulting in absorption of the lime salts. This absorption takes place by halisteresis, Volkmann's perforating canal and osteoclast absorption. The osteoclasts destroy everything that retards the advancing tooth, hence the removal of the roots of the temporary teeth. The coming tooth need not be in contact with the absorbed root, since inflammation may extend quite a distance beyond the advancing crown. Absorbed and absorber, according to Sudduth, must be in direct contact, hence osteoclasts are found in close proximity

to the roots of the teeth. The papilla or sac has no direct connection with root absorption except so far as the fibrous tissue therein contained—like the trabeculæ—may hold the osteoclasts in connection with the tooth root.

The question arises, "Why are not the roots of temporary teeth having dead pulps absorbed on the approach of the erupting teeth?" To understand why, formation of an alveolar abscess or destruction of the process without abscess must be studied. Irritation producing inflammation is transferred to the pulp canal instead of being in the alveolar process. The products resulting from the dead pulp irritate the peridental membrane, Fig. I, which begins to thicken. (Figs. I, II, IV illustrate peridental abscess upon the side of the root, and demonstrate alveolar abscess as well, the only difference being the cause and location of irritation.) This inflammation pro-

FIG. 3.

duces halisteresis and Volkmann's perforating canal absorption. The lime salts in the inflamed area are thus destroyed. The fibrous tissues or trabeculæ become organized and later break down into pus, Fig. II.

Fig. III is a high magnification showing round-cell infiltration and breaking down of tissue into pus. The pyogenic membrane forming the abscess walls is well shown. Fig. IV shows a fully developed abscess.

In temporary teeth with large pulps and apical foramina, when death results, large quantities of gas escape into the tissue, producing irritation, inflammation and alveolar destruction, and the irritation may be so severe that not only are the lime salts destroyed but

also the trabeculæ and the root attachments which hold the osteoclasts in position and are without abscess.

Fig. V, taken from Black, Vol. 1, page 936, American System of Dentistry, demonstrates the condition just described. It will be noticed that there is a space in the alveolar process and that the apical end of the root is denuded, the fibrous tissue being entirely destroyed. In either case the osteoclasts cannot come in contact with the root of the tooth, wherefore root absorption is impossible.

Fig. 4.

In other words, if the trabeculæ of the alveolar process which hold the osteoclasts be not in direct contact with the root of the tooth, irritation and inflammation caused by the erupting teeth cannot produce root absorption.

With the alveolar process, considering its sensitiveness to irritation and methods of absorption, it is not difficult to understand why replantation and implantation of teeth should so often be but partially successful. Teeth that have been knocked out, extracted by mistake, or implanted in the alveolar process in its constructive

stage, may do well. When the constructive stages cease the process becomes sensitive and absorption rapidly ensues, so difficulty occurs. If a tooth has been extracted from or a cavity drilled into the alveolar process for the purpose of implantation or transplantation, inflammation at once occurs and halisteresis and Volkmann's perforating canal absorption commence. When a foreign body is implanted in the cavity it acts more quickly. When the lime salts are destroyed about the cavity the fibrous tissue or trabeculæ may become organized (if the irritation is not too severe), fit tightly about the irregular root and give support to the osteoclasts, which commence to absorb the foreign substance.

Absorption of the roots of teeth in connection with crown and bridgework is far from rare. Crowns or bridges or too great pressure from the opposite jaw and teeth result in irritation and inflammation in and about the root, causing bone and root absorption. On the other hand, if the irritation be not too severe the osteoblasts may deposit new bone material, thus tightening the teeth in the jaws.

Fig. 5.

This is especially true of the early constructive stage of the process. The evolution of the process intended it to support one crown on each single or double root. When more force is applied the process naturally gives way.

Fig. VI is the cross-section of the jaw, alveolar process and tooth of a dog which had interstitial gingivitis. It shows the alveolar process, peridental membrane, root of tooth and pulp chamber. It also shows root absorption (osteoclast) commencing at three localities. R A, along the side, due to interstitial gingivitis.

While the jaws and alveolar process are in the constructive stage, if the person be healthy there is little or no danger of osteomalacia or senile atrophy. The constructive stage usually extends through the third and into the fourth period of stress. On the other hand, with a neurotic or degenerate child osteomalacia or senile atrophy may occur at any period from that precocity which is an expression

Fig. 6.

of premature senility. What is true of neuroses or degeneracy is likewise true of disease. Diseases involving the nervous system cause early in life inflammation of the alveolar process with absorption. If such marked results obtain in the constructive stage of the alveolar process, what is to be expected later in life when the process has reached its acme.

It is usually after this period that implantation, replantation and often regulation of teeth are done. The operator must therefore be familiar with the patient's system. If an eliminating organ be not doing its work, or if stomach or intestinal digestion from liver insufficiency result in autointoxication, success cannot be expected. The dentist should know the condition of his patient's system as well as the condition of the alveolar process. If interstitial gingivitis be present, due to systemic conditions, it must be reduced. Halisteresis and Volkmann's perforating canal absorption are already present. Osteoclast absorption must not aid them, otherwise root absorption will follow.

The patient should be prepared for these operations as the surgeon prepares a patient for a surgical operation. The indications are the same and the same methods must be adopted. Inflammation must be reduced as well as the causes which produce it.

In connection with pathology of the alveolar process and teeth, the article would not be complete without referring to the elongation of teeth. The removal of teeth from one jaw causes those on the opposite to elongate from want of antagonism. One or all of the six anterior teeth, upper and lower, are liable to lengthen. A low form of inflammation is set up in the alveolar process. If mild it causes the odontoblasts to build up bone cells and produce hypertrophy of bone and elongation of the alveolar process. If the inflammation be more severe halisteresis, Volkmann's absorption and the osteoclasts destroy the alveolar process, and elongation and loosening of the teeth result.

PERIDENTAL ABSCESS.*

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D.

Peridental abscess was first brought to the attention of the profession, if I am not mistaken, by Dr. Edwin T. Darby of Philadelphia in a paper read before the Pennsylvania State Dental Society in 1880.

FIG. 1—Inflammation of the peridental membrane.

I was the first to demonstrate this abscess in a paper published in the *International*, April, 1896. Since then I have in connection with my research work demonstrated it many times in nearly all cases in which the gums and alveolar process are involved. In this paper peridental abscess will be demonstrated as a result of some of the more marked diseases.

Pathology of the structure which surrounds the teeth cannot be understood unless the normal condition be known. The alveolar

*Reprint from DENTAL DIGEST, June. 1903.

process is composed of loose or cancellated bone structure and is solely for the purpose of holding the teeth in place. When the teeth are absent the alveolar process is not present. In the lower vertebrates there is a continuous succession of teeth (polyphyodontia). When one tooth has performed its function it disappears to give way to another. This continues throughout life. In the development of man change occurs. The two-set or dyphyodontia condition has developed. The alveolar process and teeth have, how-

Fig. 2—Thickening of the peridental membrane with abscess.

ever, retained remnants of the physiologic processes of removing useless structures. Should man live long enough he would normally lose his second set of teeth by osteomalacia or senile absorption. This is one factor of the transitory nature of the alveolar process.

Another factor has been brought about by the evolution of the jaws. Human jaws once measured 2.75 inches laterally. There was excessive prognathism. Much work was performed by the jaws and teeth. These have been growing smaller and smaller, until to-day the former measure two inches in diameter. Prognathism has approximated orthognathism. That etiquette which encourages mastication with the lips closed has had much to do with the disuse of the jaws. When the teeth have not grown smaller in proportion,

irregularities result. Having these two great factors with which to contend, the alveolar process is necessarily the most transitory structure in the body. Hence it is likewise the most morbidly susceptible.

Other than for etiologic purposes, it is erroneous to speak of "Many forms of gingivitis," as to state, "the disease presents two, three, four or five different forms, etc." No matter whether the

Fig. 3—Inflammation of the gum.

irritation be local or constitutional, the result and the pathology are the same.

Inflammation in the alveolar process and soft tissues takes the same course it would in other bones and soft tissues. It will either terminate in resolution, and the structures return to nearly normal, or it will result in absorption, ulceration and abscess. Inflammation either builds up the structure, as in hypertrophy, so beautifully illustrated by Dr. G. Lenox Curtis in "Syphilitic Locolosis Alveolaris" (*Jour. Am. Med. Assn.*, June, 1900; *Digest*, 1900, p. 664), or it destroys the bone by absorption.

Irritation when local first produces gingivitis which, becoming chronic, extends to the alveolar process and assumes an interstitial character. When irritation is constitutional, due to autointoxication or drug-poisoning, the alveolar process and deeper tissues become involved, then assuming an interstitial character, later affecting the gums, producing gingivitis.

How susceptible the alveolar process is to interstitial gingivitis is well illustrated in everyday cases. Extract two teeth upon one jaw,

Fig. 4—Round-cell infiltration from arteries.

and inflammation about the tooth or teeth having no occlusion sets in, bone cells are deposited, and the alveolar process elongates, carrying the tooth or teeth upwards or downwards until occlusion is restored. Later, when autointoxication takes place, violent inflammation sets in, with marked interstitial gingivitis, absorption and loosening of the teeth.

A seamstress bites her thread, and interstitial gingivitis results, with absorption of the bone and loosening of the teeth. Persons of very low vitality, poorly nourished people suffering with prolonged

sickness, and pregnant women have general interstitial gingivitis. Persons overworked or suffering with neurasthenia are prone to it.

In syphilis interstitial inflammation is set up not only in the alveolar process, but in all the bones of the body also, causing hypertrophy as well as absorption and death of bone. Heat and allied irritation will produce interstitial gingivitis and bone absorption.

Some more severe forms of interstitial gingivitis deserve attention from the irritation point of view. I have for years moved the teeth

FIG. 5—Inflammation and fibrous tissue.

of dogs with regulating appliances, using a screw with 60 threads to the inch. In some the screw was turned one-fourth around, in others one-half, and in still others one full turn once a day. Some of the dogs were killed in three days, others in a week, and still others in two weeks. By this method the simplest and most severe forms of pressure were applied, the length of time being brief as well as extended. These tissues were decalcified, cut, stained and mounted for the microscope. In every case inflammation was produced. This disproves the theory so long held, that bone absorption

in regulating teeth is purely a physiologic process. Teeth were also extracted from dogs, and after a week they were killed. The bone was decalcified, cut, stained and mounted for the microscope. The absorption was inflammatory in character. The jaws of dogs and monkeys who were erupting the permanent teeth were treated in like manner. Absorption of the alveolar process to allow the teeth to pass into position was of inflammatory type. Simple irritation as well as severe pressure hence produces the same pathologic process, inflammation or interstitial gingivitis.

Fig. 6—Inflammation without fibrous tissue.

The blood vessels which supply the gums, peridental membrane and alveolar process are, as I have elsewhere demonstrated (*International,* April, 1896), closely connected. Those in the peridental membrane form a plexus along the wall of the alveolar process, while only a small number are near the roots of the teeth. So closely connected are these that the vessels in one cannot become involved without involving those of the other tissues. Hence, gingivitis occurs which in reality becomes interstitial, or interstitial inflammation appears which in reality becomes gingivitis. No matter what the cause

may be, or whether the inital lesion be in the gum or interstitial structure, absorption of the alveolar process results.

Three forms of absorption of the alveolar process are always present—halisteresis, Volkmann's perforating canal absorption, and lacunar or osteoclast absorption. These are named in the order of the rapidity with which they destroy the alveolar process. Inflammation and bone absorption may and do go on for years without pus infection. Pus germs may be carried to any part of the inflamed process, as I have elsewhere shown. An abscess may form at the

Fig. 7—Acute inflammation.

border of the alveolar process, or it may form upon the periosteum at the outer border. Owing to the tortuous position of the blood vessels in the alveolar process, the pus germs usually collect at the border, stasis of blood generally being greatest at that point. I first demonstrated in 1896 absorption of the alveolar process, thickening and breaking down of tissue into an abscess. This tooth was taken from the mouth of a man fifty-four years old. He was suffering from autointoxication, due to neurasthenia from overwork, with a slight attack of Bright's disease, Figs. 1 and 2. These are of low

FIG. 8—Formation of two abscesses.

magnifying power. Fig. 1 shows the first stages, round-cell infiltration and thickening of the peridental membrane, with correspond-

FIG. 9—Inflammation due to mercurial poisoning.

ing absorption of the alveolar process which does not show here. Fig. 2 illustrates thickening of the peridental membrane, which in reality is nothing more than a large area of fibrous tissue, the result of absorption of the lime salts of the bone, leaving the mesh of fibres, which occasionally come away with the extracted tooth. The pathologic state is here farther advanced than in Fig. 1. In the center of this thickened mass is seen a white area at D, a breaking down of tissue. To the right and near the edge the tissue has broken down

FIG. 10—Abscess due to mercurial poisoning.

and an abscess has formed. In 1897, in an article read before the Section on Stomatology of the American Medical Association, I demonstrated the pathology of the disease from simple inflammation to the breaking down of tissue. The pathology here pictured in this series is illustrative of that in all peridental abscesses.

The following are illustrations magnified 480 diameters. Fig. 3 shows gum tissue with round-cell infiltration due to irritation from a gold crown. Tooth loosened and was removed. Fig. 4 is a cross-

section of peridental membrane of the left inferior central incisor of a lady twenty-nine years old, who had been under my care for fourteen years. Owing to her occupation, that of dressmaking, she had no exercise. She was in the habit of biting her thread with this tooth. She drank no water. The result was autointoxication. Two cross-sections of blood vessels are seen considerably thickened (endarteritis obliterans, with round-cell infiltration about them.-

The following four illustrations show different stages of inflammation and degeneration of the peridental membrane of the right superior first molar in a forty-year-old lady, marked neurasthenic,

FIG. 11—Inflammation due to lead poisoning.

who has had interstitial gingivitis with pyorrhea for the last twenty years, and is now losing teeth very rapidly. Fig. 5. Cross-section of palatal root near apex, showing connective tissue with active inflammation. Fig. 6. Cross-section farther down, showing further stage of inflammation of the peridental membrane, with all sizes and kinds of connective-tissue cells and round-cell infiltration. Fig. 7. Cross-section still farther down on the same root, showing further stage of inflammation. Fig. 8. Cross-section lower down and of low magnifying power, shows degeneration and liquefaction of tissue. Two areas with violent round-cell inflammation about to break down into abscesses.

From paper No. 4, Pyorrhea Alveolaris in Mercurial and Lead Poisoning, *Cosmos,* 1897, I quote the following: Fig. 9 illustrates active inflammation of the peridental membrane in a forty-eight-year-old merchant who was a dyspeptic, debilitated and asthmatic. He had been under calomel and tonics for less than two weeks. When he came under observation the mucous membrane and gums were much inflamed, there was marked sialorrhea, the teeth were loose, the gums were swollen, pus oozed from the gums, and the breath had a decided metallic odor. At my suggestion his medical attendant stopped the calomel. He was then ordered six pints of spring water daily. The gums were on alternate days saturated with iodin. In a few days the soreness and swelling were so reduced that the deposits could be removed. In a short time the patient was discharged cured, other than as to the right inferior second molar, which was so loose as to require removal. This tooth was placed immediately in fifty per cent alcohol for twenty-four hours and then removed to absolute alcohol for twenty-four hours more. The membranes had

FIG. 12—Four abscesses due to lead poisoning.

receded about two-thirds the length of the root. Sections for microscopic purposes were made from the lower third of the root. Of these sections Fig. 9 shows a small fragment or inflamed peridental membrane. Fig. 10 exhibits violent round-cell inflammation, degeneration and liquefaction of tissue or abscesses.

A thirty-five-year-old diabetic painter came under observation for lead poisoning. His gums were swollen, there was decided sialorrhea, the teeth were loose, and pus flowed from the gums. He was placed on ozonate spring water and the gums were saturated with

FIG. 13—Four abscesses in a 64-year-old diabetic man.

iodin on alternate days. Three loose teeth were removed and placed in alcohol. Sections from the upper third of the left superior second bicuspid, on microscopic examination, gave results similar to those already described in mercurial poisoning. Fig. 11 shows round cells of inflammation. Fig. 12 illustrates very marked degeneration of the peridental membrane. In the right-hand corner are seen root of the tooth, dentin and cementum. The whole surface of the peridental membrane is in an advanced stage of inflammation. Just at the border of the root is evident an area of membrane softening. Just be-

yond, but joining, is noticeable breaking down of tissue. In the center are seen two areas of softened tissue more advanced in degeneration.

Two cases that have never been published are added to my collection of slides showing peridental abscess. These illustrate the wide range of diseases in which it may occur. Fig. 13 (X50) illustrates the four stages of abscess in the peridental membrane of a sixty-eight-year-old man, a contractor. He was a diabetic, a neurasthenic,

FIG. 14—Scurvy. Round-cell infiltration from three small arteries.

with autointoxication which finally culminated in kidney lesions. The illustration shows active inflammation at different points, the two lower areas breaking down and liquefaction of tissue. The upper space shows an abscess with bacteria within, while without is seen round-cell inflammation.

The following scorbutic case was referred to me by Dr. George W. Johnson: A twenty-five-year old American was admitted to Cook County Hospital for the Insane December 2, 1892, suffering

with melancholia, attended by delusions of persecution, and suicidal tendencies marked by refusal of food. June 1, 1896, he again began to refuse food, but took liquid diet on persuasion. June 29 the patient was transferred to the hospital because of his emaciation, and scorbutic symptoms were discovered. July 18 the constitutional and local symptoms of scurvy were well marked. The teeth were covered with sordes and loosened. Under antiscorbutic treatment these symptoms had fully disappeared by August 13.

Fig. 15—Scurvy. Formation of abscess.

Through the kindness of Dr. Johnson I was allowed to see this patient. I found none of the teeth very loose, showing the disease was superficial. I removed two teeth that were decayed and the most loose. These were prepared for the microscope in the usual way. Fig. 14 shows the gums and peridental membrane in an active state of inflammation. Small blood vessels are observed in different localities, with round-cell infiltration extending into the tissue. Fig. 15, the root of the right superior second bicuspid with peridental

membrane attached, shows active inflammation about an artery which has thickened, and an area of tissue degeneration, forming an abscess.

I will now call attention to another form of abscess of common occurrence, but as yet undescribed. In interstitial gingivitis absorption of bone takes place by halisteresis, Volkmann's perforating canal absorption, or lacunar or osteoclast absorption. In nearly every case, as I have elsewhere shown, this absorption so takes place that islands of bone become dislodged. Fig. 16. These cause irritation, pus germs infect the part, and abscesses result about the roots.

× 50, ½-inch objective, No. oC.

Fig. 16—Cross section of tooth, alveolar process and peridental membrane, showing lacunar absorption. Man. C, cementum; D, dentine; I, peridental membrane; J, alveolar process; O, lacunar absorption.

of the teeth. The pus burrows its way to the surface and spiculæ of bone are discharged. The abscess may heal of its own accord, but treatment is generally necessary.

That the calcic deposit upon the roots of teeth and in abscesses is due to absorption of the alveolar process there can be no doubt. In 1898 Dr. George T. Carpenter and I independently made extensive experiments upon pus in abscesses and pockets, each with the following results. Summing up, Dr. Carpenter pertinently asks: "But can tissue be absorbed and still remain as debris in the pocket? Such is the condition found in pyorrhea pockets, which can be easily proved by taking the contents of a pocket, dissolve it in hydrochloric acid, add three times its bulk of water, filter, boil, and when cold add a solution of ammonia, which will precipitate the phosphate of calcium. The same result is attained by rinsing a freshly-extracted, roughened, pyorrhea root in cold water, then with a stiff brush and water brush the roughened parts and put the resulting product into a test-tube, add hydrochloric acid and water if necessary, filter, boil, and to this add a solution of ammonia, and the lime salts are precipitated."

I collected the contents of peridental abscesses in a sterilized teaspoon, and Dr. Wesener, chemist of the Columbus Medical Laboratary, found that there was an average of eight times more lime salts in the pus cavities than in normal blood. Since stasis of blood has taken place in a large area about the abscesses and pus pockets, deposit from the vessels seems out of the question.

BUCCAL EXPRESSIONS OF CONSTITUTIONAL STATES.

BY EUGENE S. TALBOT, M. S., D. D. S., M. D., LL. D. READ BEFORE THE CHICAGO ACADEMY OF MEDICINE, OCT. 2, 1903.

(Reprint from DENTAL DIGEST, November, 1903.)

There was a tempest in diagnosis over the death beds of Mary II of England and Louis XV of France, who both died of small-pox. The tempest in the case of Mary was due to a fight between society physicians and medical politicians, and was settled by the dictum of Radcliff, who had rare skill in diagnosis. The medical contest over Louis XV (1774) was essentially one between the partisans of the courtesan, Dubarry, and those of the Dauphin, afterward Louis XVI. The hesitation was pardonable, since forty-six years (1728) previously Louis XV had an attack of small-pox. The contest was more over the gravity of the disease than its type.

It is a singular illustration of the value of local conditions in diagnosis, as Voltaire points out, that just before the more serious symptoms of variola made their onset in 1774 Bourdet, the King's dentist, examining the royal mouth, recognized by the appearance of the gums the premonitory symptoms of a serious malady and communicated his apprehensions to one of the ministers of state. Bourdet (Cabane's Secret Cabinet of History, page 49), like reputable dentists of that time, was medically educated, and so far as diagnosis then went was trained in local aspects of constitutional disease. Ere the days of the thermometer, stethoscope, and what are called instruments of precision, training in local expression of constitutional states was of necessity more exact and minute than when these instruments were at the service of the physician.

Clinicians, however, continued to value local manifestations. Obstetricians studied the mouth of pregnancy, alienists studied the mouth under scorbutic and cachetic aspects, and under those presented by paretic, paralytic, senile and terminal dementia.

As late as 1881 James Tyson (Bright's Disease and Diabetes) cited as local manifestations of diabetes "a spongy state of the gums, with recession and excavation resulting in extreme cases in absorption of the alveolar process and falling of the teeth." Magitot and

other French clinicians had pointed out previously similar buccal manifestations in other constitutional states as well.

The disease called "pyorrhea alveolaris," under the most exact views of its pathology forced by bacteriology, especially the phase related to culture mediums, stimulated a more exact study of the constitutional states underlying buccal changes. In a discussion of the subject some years ago I pointed out that these might, like all local manifestations, have several relationships to the coincident constitutional state, they might be an expression of that state, they might be a complication, they might be an etiologic factor; or they might be a mere coincidence. This is true of all local manifestations, the medically vicious reflex hypothesis to the contrary notwithstanding. In a recent article influenced by the now general trend of specialties of medicine to consider constitutional relations of the local states, Campbell (British Dental Journal, June, 1903), ignoring most previous dental and medical literature, points out that the state of the mouth is to a considerable extent an index to the condition of a person's health. If an individual be free from bodily ailments, then as a rule the teeth and gums are sound and healthy. The state of the teeth must exert a constant influence upon the condition of the body, and as truly the general condition of the body exerts an important influence upon the state of the teeth, and it is this close relationship of the state of the mouth to the state of the general health that makes the work of the dental surgeon of such paramount importance and interest to the physician.

By some it is asserted that morbid states of teeth, gums, alveoli, etc., are the cause of certain diseases. Hunter has endeavored to show that buccal sepsis, having its origin in long-continued and neglected cario-necrotic condition of the teeth, is the cause of pernicious anemia. This is due to special infection of the digestive tract, caused by buccal sepsis. Campbell, while not denying to buccal sepsis a contributory etiologic nature which in some cases may be considerable, is nevertheless convinced that it is not only not entirely responsible for the etiology of the disease but generally plays a minor part. He carefully investigated the condition of the mouth in every case of pernicious anemia that came under his notice, and found that while in the majority the gums were spongy, the teeth loose, with pus welling up by their sides and the gums receding, in others the teeth and gums showed no sign of the disease. According

to his observation, such buccal conditions are an outcome rather than a cause.

The dental condition most frequently met with in diabetes is a loosening and painless shedding of sound teeth. Dental caries, gingivitis, and spongy or bleeding gums occur at times. Changes in the teeth due to the imperfect calcification of the enamel or dentin often supply a valuable record of the patient's biology. Other conditions of the mouth which will serve as a useful guide to the physician in making a diagnosis are the ground-down teeth of the gouty occasionally met, dental periostitis of the rheumatic, and caries or impaction as a cause of various ailments of children. Suspicion as to the presence of tubercular disease may be aroused from the pallor of the mucous membrane, or of Addison's disease from the presence of pigmentation. Certain poisons produce marked changes in the jaws and gums.

The condition of the teeth and gums affords satisfactory testimony as to the general state of health of an individual and is an invaluable aid to the physician in making a diagnosis. Owing to the transitory nature of the gums and alveolar process, and the fact that arteries and nerves therein contained are end organs, autotoxic and toxic states are often there indicated long before disease presents itself. Rapid decay of the teeth indicates neurasthenic, degenerate, autotoxic and toxic conditions. Disorders of the teeth and gums cause accumulation of pathogenic bacteria which produce diphtherial, pneumonic, tubercular, and other mouth and throat lesions. Pus germs taken into the stomach and intestines cause indigestion in both. If inflammation of the intestinal tract be present pus germs will infect the part. Matter circulating in the blood causes irritation in the capillaries in the alveolar process. Odor is an expression of this poison eliminated through the throat and lungs.

In gout, rheumatism, Addison's disease, and most allied diseases peripheral nerves are irritated and degenerate. This is likewise true of the dental pulp which, as I have elsewhere shown, has a vasomotor system. When disease occurs the pulp nerves are irritated, and the arteries dilate and contract, modifying tooth resistance. Tooth decay so common in all constitutional disease is due to a want of tooth resistance. Pits and furrows upon the teeth indicate arrest of development due to malnutrition in utero or after

birth while the teeth are forming. They may be due to syphilis or many other causes.

In dealing with the influence of buccal states on the constitution it must be remembered that when the eliminatory system is overstrained, especially when the poison-destroying function of the liver is deficient or impotent, the throat and gums play a great part in elimination, whence come, for example, the "blue" gum of lead-poisoning and the "green" gum of brass, as well as those from mercury, arsenic, potassium iodid, bromid, etc. Matter thus eliminated is reabsorbed, enters into the chyle with digested products. and readily becomes toxic to the blood cells. That cachetic states approximating pernicious anemia can thus be produced is clearly evident. Were fecal anemia existent ere the gum and throat changes were set up it would thus be greatly intensified. The toxemia producing this gum and throat state would be greatly increased through the overstrain of oxidizing processes produced by reabsorption of eliminated products. Interstitial gingivitis or pyorrhea alveolaris can, as Fitzgerald (Clinical Journal, March 6, 1899) and I have shown, be predisposed by neurasthenia and aggravate this.

The toxins generated in the mouth readily pass into the general system. As a result, chronic indigestion with coexistent pigment spots, urticaria, etc., may occur, as Herschell (Indigestion, 1895) has shown. Pus toxins, as in a case reported by Carr and Boughton (Lancet Aug. 22, 1903), may thus produce a sapremia mimicing typhoid, as pigment spots readily simulate the typhoid eruption. In buccal manifestations of constitutional disease the vicious circle of pathology peculiarly occurs.

SECTION III.

DEVELOPMENTAL PATHOLOGY

OF THE

PULP AND TEETH

1 EVOLUTION OF THE PULP.

2 THE VASO-MOTOR SYSTEM OF THE PULP.

3 PULP DEGENERATION.

4 CONSTITUTIONAL CAUSES OF TOOTH DECAY (Internal).

5 CONSTITUTIONAL CAUSES OF TOOTH DECAY, EROSION, ABRASION, AND DISCOLORATION.

6 DEVELOPMENTAL PATHOLOGY AND TOOTH DECAY (External).

7 ADVANCE AND RETROGRESSIVE EVOLUTION.

EVOLUTION OF THE PULP.*

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It has often occurred to me that conditions other than the toxins producing lactic acid were instrumental in decay of the teeth. This and interstitial gingivitis result from a struggle for assimilable nutriment dependent upon the action of the nervous system, operating through the law of economy of growth.

Elsewhere I have demonstrated the relation of degeneracy to the struggle for existence between the face and brain, the jaws and brain, the alveolar process and the jaws and face. I shall now discuss degeneracy of the teeth and their pulps, in relation to evolution.

In its evolution every structure in the body passes through embryologic phases[1] resembling types found in the lower vertebrates. In such evolution it is affected beneficially by both degeneracy or the suppressive phase of evolution and the advance phase. These phases constitute a struggle for existence for assimilable nutriment which proceeds under the law of economy of growth. If this law of economy of growth proceed in a balanced manner the structure type is developed, although not to the full extent promised in the child. In this development the contending influences of remote atavism. immediate atavism, type heredity and immediate heredity all play a part. In the earlier phases of embryologic

* Read at the Fifty-third Annual Meeting of the American Medical Association, in the Section on Stomatology, and approved for publication by the Executive Committee: Drs. G. V. I. Brown, M. H. Fletcher and R. R. Andrews.

1. In this paper I have made large use of Willey's work on the Amphioxus of Lyddecker, of Tomes, and other comparative anatomies.

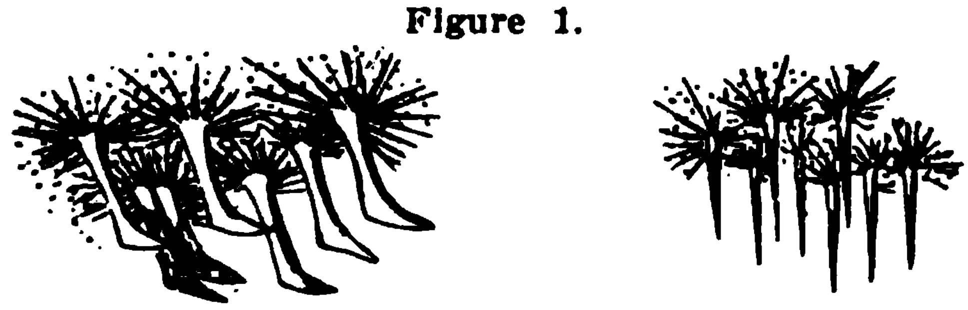
evolution remote atavism has seemingly most sway. For this reason structures appear early in embryonic life, only to disappear through the beneficial influence of type heredity aided by immediate atavism and by immediate heredity. Degeneracy at this phase plays a salutary part in causing disappearance of useless structures, thus placing organs in shape for new functions. Nowhere is this process better illustrated than in the teeth and their pulps whereby what was originally a placoid scale becomes a tooth intended for the utilization of nourishment. While the individual development of an organ, as DeMoor points out, is a compressed résumé of its historic evolution, still such a recapitulation must be only a more or less vague repetition of the essential phases of phylogeny. The development of the child, for example, exhibits "short cuts" and phases of direct development due to adaptation destroying the exactness of the parallel with phylogeny. The question, however, of these "short cuts" depends on the operation of the forces already described and the influence of the disappearance of rudimentary organs. It frequently happens that rudimentaary organs are preserved on account of their insignificance alone. Thus occurs the persistence of accessory rudiments of enamel organs in the development of teeth. Besides the rudiments of the enamel organs for the milk teeth and the permanent teeth, there are additional organs present in a variable condition and number nearer the external surface. They are very generally present and markedly resemble the youngest stage of the normal enamel organs. According to Kollman and Gegenbauer, they are abortive rudiments surviving from an ancestral condition in which teeth were more numerous.

Development of the tooth from the placoid scale (Fig. 1) turns on development of the mouth. In consequence of the increase in the size of the brain, its forward extension and its cranial flexure, together with the relative reduction of the head cavities and the mouth, as Willey remarks, has been carried round from its primitively dorsal position to its final position on the ventral side of the head in the craniate vertebrates. According to Dohrn, the vertebrate mouth results from the fusion of two gill-slits. The annelid mouth which perforates the central nervous system in passing through

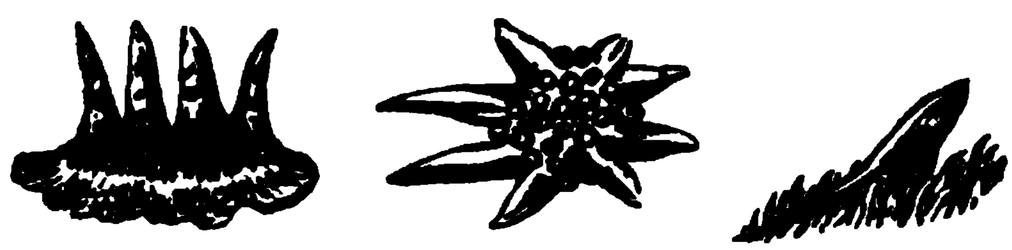
the circumesophageal nerve collar has become aborted and is replaced by a new mouth derived from a fusion across the mid-ventral line of a pair of gill clefts. The hypophysis cerebri represents, according to Beard, the remains of the old annelid mouth. This double origin of the mouth has been particularly well shown in the embryos of the toad-fish by Cornelia Clapp. The toad-fish is, however, a comparatively high type. The mouth in vertebrates has undergone an evolution from a round (cyclostomous) to a jaws (gnathostomous) condition.

Development of the pulp illustrates clearly irregularities in type arising from the operation of the law of economy of growth as modified by environment and the

Figure 1.



Dermal papillæ of Monacanthus trossulus.



Dermal papillæ of Monacanthus hippocrepis (magn.)

consequent necessities of the animal. The pulp in some vertebrates becomes, as Tomes remarks, eventually converted into secondary dentine, but generally those teeth which exercise very active function and last throughout the life retain their pulp in an active and vascular condition. The variations in the condition of the pulp are by no means limited by zoologic classes. For the purposes of the present discussion the classifications of Huxley are most suitable. These include the *Ichthyopsidæ* (which comprise the fish and batrachians), the *Sauropsidæ* (reptiles and birds), the monotreme mammals, the marsupials and mammals proper. The line of development of the tooth is shown in the more or less constant relationship between the skin and the teeth which appear as the scale above the *Icthyopsidæ* is reached. The

law of economy of growth in the higher *Sauropsida* peculiarly illustrates this. The lowest fish (*Amphioxus*) has no jaws and no teeth. In the next class, the lampreys have a cartilaginous skeleton and are cyclostomous[2] (Fig. 2). There are no jaws and the mouth is surrounded by a circular lip, beset with rows of small, conical teeth. The larger blade-shaped teeth, called the mandibular and maxillary teeth, are in the center. These horny teeth, resting upon a slight dermal papilla, fit into special epidermal depressions at the base of the papilla. In lampreys there are superimposed cones. (Fig. 3.) Each of these layers arises from a separate epidermal depression which goes on continually forming horn, so that the under cones are in no sense reserve teeth, for as each tooth is worn away at the apex fresh horny matter is formed below and pushed forward. There is thus no resemblance to most teeth of higher vertebrates. In young lampreys are found what at first sight seems a true tooth sac, but the dental papilla never forms any odontoblasts and the epithelium, which corresponds to the enamel organ, produces horn. This is true of the marginal teeth, but further in towards the center the teeth are formed simply in the basal layers of the epithelium without the intervention of any sort of tooth sac. In the *Myxine* and *Bdellostoma* of the same class are a large sharply-pointed medium tooth and two cone-like teeth upon the tongue. The working surface of the teeth is composed of horn like that found in the lamprey.

The tooth of *Bdellostoma* consists of a horn cap, thick, strong and bright yellow. Beneath this is a layer of epithelium and next a hard, calcified material, which Beard regards as a form of dentine. The horny cap fits into an epithelial groove at its base, increases in length by the cells of this groove becoming cornified. and in thickness by a similar conversion of the epithelial layer beneath it. The hard cone forming the body of the teeth, while not closely corresponding to any known dentine, is undoubtedly the product of an odontoblast layer upon the pulp, which latter remains in the base of the dentine cone in the usual way. The relation which the horn cone bears to the dental papilla and its dentine is entirely different from that borne by the horny teeth

2. The following illustrations are taken from Günther.

of the ornithorynchus, in which the horny plate that takes the place of teeth in the adult lies beneath the teeth. In expressing this opinion, Tomes to some extent ignores the phenomena of evolution by atrophy through which structures disappear by the law of economy of growth for benefit of the organism. The third eye of man through the operation of this law becomes the pineal body. Through distant atavism and acquired defect gaining ascendency, the type eyes sometimes atrophy for the benefit of the central eye and a cyclops results. The same conditions occur in the evolution of the kidney in the human fetus. Certain structures are formed only to disappear for the benefit of the type kidney. That the horny teeth and the teeth might have in this way independent origin does not seem to have occurred to Tomes or to Beard. Beard is of the opinion that the fusion of the

Fig. 2.—Mouth of Larva of Petromyzon branchialis.

Fig. 3.—Mouth of Petromyzon fluviatilis. *mx*, Maxillary tooth; *md*, Mandibulary tooth; *l*, Lingual tooth; *s*, Suctorial teeth.

lingual teeth of *Myxine* into a serrated plate may indicate the manner in which the serrated horny jaws have originated in turtles as a substitution for the true teeth upon which they were once superimposed. Tomes suggests that there is no material for this or the similar hypothesis of the origin of the bird's bill from the substitution of a number of coalescent horny teeth for true teeth. Since the horny beak of the cuttle-fish somewhat resembles the beak of birds, and since the cuttle-fish in many respects is of comparatively high development, it is by no means improbable that similar conditions were found in ancestors of the vertebrates.

The jaws, as Minot has pointed out, a later gain of the vertebrates, are absent in the amphioxus and lampreys and other *Cyclostoma*. Man and the anthropoids

retain more of this embryonic feature than many of the lower mammals.

The mouth of the amphioxus is essentially an organ of the left side, homologous neither with the ascidians nor with the craniate mouth. The phenomena connected with the devolpment of the mouth in the amphioxus throw light on the development of placoid scales in the interior of the body. In sharks, the scales of other fish are replaced by a papilla which have somewhat the same structure as their teeth. To these the "shagreen" of the shark owes its roughness. The mouth is a transverse more or less curved fissure opening upon the under surface of the head at some little distance behind the end of the snout. Hence a shark seizing its prev turns upon its back, or at all events upon its side.

The jaws (which are made up of the representatives of the palate—quadrate arch and Meckel's cartilage; neither true maxillæ nor premaxillæ being present) are cartilaginous in the main (although covered with a more or less ossified crust) and therefore shrink and become much distorted in drying. The shape of the jaws differs in the various groups. In some each jaw is a tolerably perfect semi-circle. In others they are nearly straight and parallel to one another. In all the rounded working surface of the jaw is clothed or incased by teeth arranged in parallel concentric rows. The teeth (which are situated upon the edge or exposed border of the jaw) are usually erect. The rows which lie behind them, farther within the mouth, point backward and are more or less recumbent, not having yet come into full use.

The teeth as already shown were primitively organs of the skin widely developed over the surface of the body, which played an important rôle in the genesis of the skeleton. Fish, especially sharks (Fig. 4) are hence the source of study of the primitive mode of tooth formation. The tooth of the shark begins as a mesenchymal (body between the ectoderm and entoderm) papilla, composed of crowded cells and projecting into the epidermis. The layer of epidermal cells overlying the papilla changes in character (its cells gradually lengthening into very long cylinders) and becomes the enamel organ by further development, the epidermis thickens, the papilla projects into it, becoming narrow and longer and, taking an oblique position, gradually assumes the shape of the tooth.

Ossification now begins over the surface of the papilla, a layer of epithelioid osteoblasts arises and between these and the enamel organ the development of bone or ivory begins. The osteoblasts persist and the bony structure is developed between them and the epidermis, forming a stratum which grows in thickness (Fig. 5). At the same time the enamel organ begins to deposit the calcified layer known as enamel over the papilla. Later the tooth acquires a support by the direct ossification of the connective tissue at its base and is then a complete "placoid scale." The teeth of the mouth depart from this primitive mode of development, since they do not arise on the surface, but deep down. The dentiferous epithelium grows down into the dermis forming the oblique shelf, which is a special tooth-forming organ.

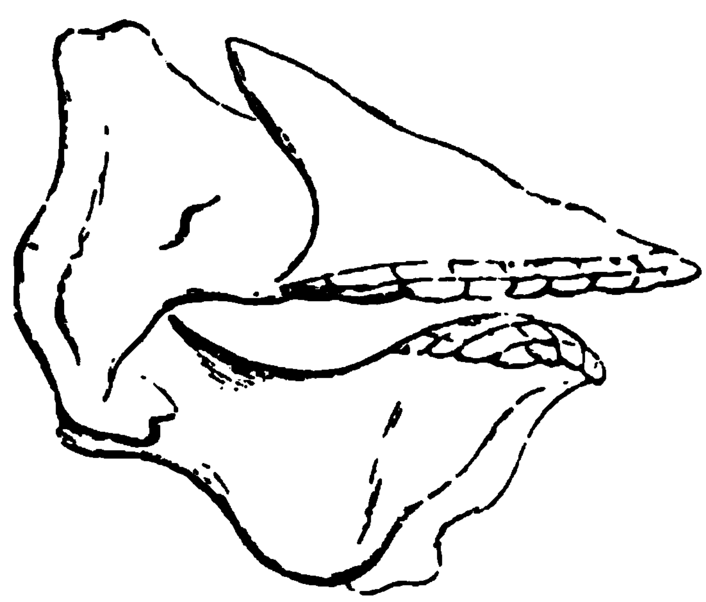


Fig. 4.—Jaws of Port Jackson Shark, Cestracion phillppi.

(Fig. 6.) On the underside of the shelf the teeth are developed in the same way as over the skin. A tooth is hence a papilla projecting into the epidermis which, ossifying in a peculiar way, changes into ivory around the soft core or pulp. To the papilla the epidermis adds a layer or enamel. The tooth proper unites with a small plate of dermal bone at its base. By a modification of the jaws the epidermis first grows into the dermis and then the dermal tooth papillæ are developed. In the higher vertebrates, teeth of the jaws alone develop in the modified way noted in the shark's jaw.

The pulp cavity contains blood vessels and nerves which enter through the opening in the root and in the pulp cavity ramify over that delicate fibroid cellular structure, the pulp. This is continuous with an in-

fantile number of small projections which extend into the tubes of dentine in the inner structure of the tooth. These tubules when fresh contain nerve and vascular processes from the pulp.

The use of the word pulp dates back, as L. C. Ingersol, Keokuk, Iowa, points out, to the time when the teeth were considered bones and when brain and bone marrow were held to be the same tissue. The brain, as Ingersol states, might with equal propriety be called the cranial pulp as the central organ of the tooth structure, the dental pulp. In Ingersol's opinion, dental ganglion is more in keeping with its character and function. It is vesicular or corpuscular ganglion rather than a tubular or fibrilous one. The nerve cells are multipolar, contributing nerve force rather than acting as conductors of sensation. (Fig. 7.) The physiologic relations of the peripheral dental plexus to the dental ganglia is most apparent in pathologic states. When an operator is working in the periphery of the dentine, the patient often insists that the instrument is in contact with the nerve. The pain is so intense and deep-seated as to be attributed to the central nerve. The converging nerve fibers afford a direct connection with the dental ganglia. Pathologic conditions of the periphery are readily communicated to the nerve center. Dentists, according to Ingersol, are so accustomed to associating fibrils of the odontoblasts with the dentine that they are apt to lose sight of their true character as prolongations of the pulp. The investigations of Tomes and others show that so-called dental fibrils are nerve fibrils—that whatever else may surround them in the tubules, they contain at least a filament of nerve tissue with characteristic nerve functions. Sudduth, while willing to admit that the fibrils perform the function of nerve tissue, doubts whether true nerve fibrils have ever been demonstrated. The dental fibrils arise from the odontoblasts which are intimate in relation with the terminal fibrils of the main nerve trunks of the pulp. The tooth pulp on whose surface the odontoblasts lie, is composed, as Stowell[3] points out, of connective tissue nucleated cells, blood vessels and nerves. The latter ends in non-medullated fibers, most numerous upon the peripheral portions of the pulp in juxtaposition with the odontoblastic layer, some of the

3. Sajous Annual, vol. v.

fibers of which pass between the cells of the latter, from which it has been inferred that they accompany the dental fibers to their termini.

In batrachians like the frog, teeth are wanting in the lower jaw. In the upper jaw they are found in two situations. Along the outer border within the lip there is a single row situated in a groove. They are also situated in a group on each vomer in the center of the vault. The roots of the teeth possess large cavities, the

Fig. 3.—Upper jaw of the same, half natural size. Port Jackson shark.

wall being thin and almost of even thickness except on the inner surface of the basal portion, where the wall is wanting, and so forms a large aperture to the root for the pulp. This, as Ecker has shown, is composed of connective tissue very rich in cellular elements. The cells next to the dentine are arranged in a layer and resemble very much the appearance of a layer of columnar epithelium. The arrangement of the minute structures are not unlike those of the human pulp. The odontoblasts

are spindle-shaped and send processes (dental fibers) into the dentinal tubules. Blood vessels are observed, but nerve fibers have not been found.

What is true of the frog in regard to large foramina in the teeth is also true of the *Sauropsidæ*, like the alligators and some snakes (the python), etc. (Fig. 8.)

Many years ago Geoffrey St. Hilaire described a series of vascular pulps on the margin of the jaw of parakeets about to be hatched, which, though destined to form a horny bill and not to be calcified into teeth, strikingly recall dental pulps. The famous fossil bird of the lithographic shale of Bavaria, had a long jointed tail and possessed teeth. Up to the discovery of this bird toothed birds had been unknown. Later, however, Prof. Marsh found nine genera and twenty species. They are referable to two widely different types. One group consists of comparatively small birds with great power of flight and having their teeth implanted in distinct sockets (*Odontotornæ,* of which the genus *Ichthyornis* is a type). The other group consists of very large swimming birds without wings, having teeth in grooves (*Odontocæ* type, genus *Hesperornis*).

In *Ichthyornis* the teeth were about twenty-one in number in each ramus, sharp-pointed and recurved. The crowns were coated with enamel. The front and back edges were sharp but not serrated. They were implanted in distinct though shallow sockets and the maxillary teeth were a little larger than those opposing them. The premaxillaries were probably edentulous and perhaps covered with a bony bill. In the lower jaw the largest teeth occur about the middle of the ramus, those at its posterior end being materially smaller and the sockets are deeper and stronger than in the upper jaw. The succession takes place vertically.

The genus *Hesperornis* (probably diving birds) includes species six feet in length. The teeth are not implanted in distinct sockets, but lie in a continuous groove like those of the *ichthyosaurus*. The slight projection from the lateral walls indicates a partitioning off into sockets, nothing more than this is attained, and after the soft parts perish the teeth are easily displaced and had often fallen out of the jaws. The premaxillary is edentulous, but the teeth extend quite to the anterior extremity of the lower jaw. In one specimen there are

fourteen sockets in the maxillary bone and thirty-three in the corresponding lower ramus.

The successional tooth germs were formed at the side of the base of the old ones and, causing absorption of the old roots, migrate into the excavations so formed, grew large and ultimately expelled their predecessors. (Fig. 9.) In structure their teeth consist of hard dentine invested with a rather thin layer of enamel and have a large axil pulp cavity. The basal portion of the roots consists of osteodentine. The outer side of the crown is nearly flat, the inner strongly convex. The junction of these surfaces is marked by a sharp ridge not serrated.

The monotremes, the lowest mammals, lay eggs, have

Fig. 6.—The sheep's head, Sargas ovis of North America. Lower jaw.

Fig. 6a.—The sheep's head. Sargas ovis of North America. Upper jaw.

a cloaca and are without nipples, the milk exuding from pores in the skin. The temperature is lower than that of other mammals. The *Echidna* have a temperature of 70 degrees. The skull is long and depressed; there is a large rounded brain case with thin walls as in birds. There are no true teeth in adult life. In the young ornithorhynchus are three flattened saucer-like teeth, in each half of the jaw, which are afterwards shed and replaced by projections or cornules. The ornithorhynchus has a broad, flat rostrum, forked in front which supports the beak and in which the teeth first and later the cornules are implanted. In the *Echidna*, the snout is long, narrow and toothless, forming a long tube for lodgement of the tongue, as in the true ant-eater. In

the *Proechidna* the snout is nearly twice as long as the brain case. The palate of the *Echidna* is covered with rows of horny spines which scrape the ants off the tongue when it is drawn into the mouth. The ornithorhynchus muzzle resembles a duck's bill and is provided with the cornules that take the place of the true teeth. The upper teeth have broad-topped crowns with two long cusps on the inner edge and a crenated border along the outer edge with many small cusps. On the lower this is reversed. They have low broad crowns with short stunted roots, which are for a time rather firmly held. They are on the top of the horny plates. The expanded crowns narrow rapidly at the neck and are surrounded by a very dense thick epithelium almost horny that rises into a ring around them and dips underneath the expanded portion so that the crown lies in a special cup of horny consistency.

This cup is not complete at the bottom, but the roots pass through it and fit depressions in the bone which is perforated by the foramina for vessels and nerves. When the animal is about twelve inches long the teeth are shed and then the horny cups grow in, underneath and become complete. The curiously sculptured surface of the horny plates has its form determined by having formed the bed for a tooth with several roots. Although the horn grows underneath and fills up the holes for the roots to go through, yet the old form is maintained by the horny plate, which henceforth serves for mastication.

The horny plates are therefore not to be regarded as horny teeth, but are epithelial structures which take the place of the teeth. They are hence not closely homologous with the horny teeth of lampreys and myxincids. The true teeth consist of a body of dentine with a central pulp cavity capped with thin but hard enamel and implanted by short roots, the breadth of crown exceeding its vertical dimension. The enamel is of simple structure. The dentine is permeated by fine dentinal tubes beset with a number of interglobular spaces, which in parts masks the tubular structure of the crown. In the principal cusp apparently vascular canals exist. Toward the stunted roots a somewhat abrupt transition in structure takes place. All dentinal tubes disappear and large lacunae appear. The roots are of softer, coarser material than the crown, which is itself not a high type

of dentine structure. There are some resemblances between the root type of the ornithorhyncus and that of the hesperornis.

Among the marsupials the dentition varies widely; this is hardly surprising since the marsupials are practically a distinct order of the mammalia containing representatives of the *Herbivora, Carnivora* and *Insectivora* of the other mammalia. The teeth are separable into different classes, but with the exception of the premolar are not preceded by milk teeth. The wombats, who represent the *Rodentia* among the marsupials, are the

A

Fig. 7.—Pharyngeal bones and teeth of Pogonias chromis. Drum fish.

only ones which have rootless teeth and an equal number of incisors in each jaw. The incisors are large and cutting with the enamel confined to their anterior surface. There are no cuspids.

Among the marsupials there is a vertical displacement and succession of the teeth except in the case of a single tooth on either side of each jaw, which is always the hindmost of the premolar series and is preceded by a tooth having the character of a true molar. This is the only one comparable to the milk teeth of the higher mammalia, all the other teeth remain unchanged. This

succession of teeth would indicate open pulps with large foramina in the roots of the teeth.

Among the mammals are forms which are absolutely edentate, have long scaly bodies and short legs and look more like reptiles than mammals. The teeth when present are always composed of dentine and cement only (without enamel), and never form roots. In only one genus (*Tatuania*) is there a functional milk dentition, one only (*Dasypus*) possesses premaxillary teeth, and in none is there any definite division of those in the maxilla into cuspids, premolars and molars.

The aard-varks have a very peculiar complex type of teeth, consisting of a very large number of separate parallel dental systems closely packed together. These teeth are preceded by a set of minute milk teeth, mere remnants of a former functional set, which show indications of a division into different groups, such as pre-molars and molars.

The armadillos have thick plates of ossified skin covering the body. In all the group teeth are present, generally twenty-eight to thirty-eight in number, but in the giant armadillo amounting to eighty to one hundred. These teeth are small and simple with single roots.

Passing upward from the papilla which forms the tooth of the placoid scale type, the relations of the pulp as regards persistence and inclosure vary widely. Permanent pulps are found quite high in the mammalia. The mastodon had permanent pulps which continue to grow and are partly coated with enamel. In this particular they resemble the rodents as well as in the absence of cuspids. There are toothed whales or *Odontoceti*, and baleen whales or *Mystacoceti*. The *Odontoceti* have no whalebone, but always possess teeth which are generally numerous, although sometimes few and quite rudimentary in size and function. The narwhal has the most extraordinary dentition of any mammal. It has only two teeth in the adult state, both of which lie horizontally in the upper jaw. In the female these remain permanently concealed within the bones of the jaw, so that this sex is practically toothless; but in the male, while the right tooth remains similarly concealed and abortive (as shown in the skeleton by removal of part of the bone which covered it) the left is immensely developed, attaining a length equal to more than half

that of the entire animal, projecting horizontally from the head in the form of a cylindrical or slightly tapering pointed tusk, with the surface marked by spiral grooves and ridges.

Although the so-called "whalebone whales" (*Mystacoceti*) have rudimentary teeth developed at an early period of life, these soon disappear and their places are occupied in the upper jaw by the baleen whalebone.

Baleen or whalebone resembles in development the cornules of the ornithorhyncus. Each plate is developed from a vascular persistent pulp which sends out numer-

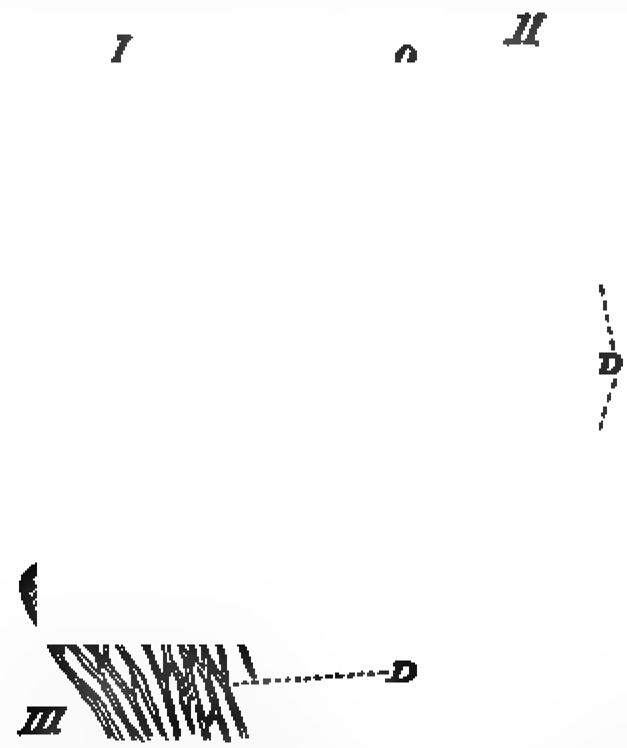


Fig. 8.—1. Transverse section of the premaxillary bone to show attachment of the teeth; after Hertwig. Magnified 22 times. 2. Dentine and enamel. Magnified 500 times. 3. Enamel. Magnified 500 times. *A*. Blood vessel of the pulp cavity. *C*. Crusta petrosa. *D*. Dentine. *F*. Processus dentalis. *H*. Layer of epithelium. *O*. Tooth cuticle. *R*. Second tooth germ. *S*. Enamel. *X*. Cutaneous glands.

ous long thread-like processes that penetrate far into the hard substance of the palate. Each hair-like fiber has within its base a vascular filament or papilla. and, in fact, is nothing but an accumulation of epidermic cells concentrically arranged around a vascular papilla, the latter being enormously elongated. The baleen plate is composed mainly of these fibers which constitute the hairs of its frayed-out edge. In adition to this, layers of flat cells bind the whole together and constitute the

outer or lamellar portion. The whalebone matrix produced by cornification of the epithelial coverings of papilla is an epithelial epiblastic structure morphologically corresponding, not with dentine, but with the enamel. The whole whalebone plate and the vascular ridge and papilla which form it are comparable to the strong ridges upon the plates of certain *Herbivora*. Study of the mouth of young whales prior to the cornification of the whalebone tends to demonstrate this. This is obviously a return to the placoid scale type carried into the interior by the mouth changes. The development recalls that of the spines on the palate of the echidna.

Manatee teeth have peculiarities unusual in mammalia. The dentine of the hard unvascular variety is permeated by a system of larger or vascular canals arranged with much irregularity and most abundant near to the periphery of the dentine where they communicated with one another. The dentinal tubes did not radiate from these vascular canals. There is an ordinary unvascular dentine with a system of capillary conveying channels inside it. These capillary channels are no longer previous, having become obliterated and presenting the appearance of greatly elongated interglobular spaces. The cuspids among the bunodonts (swine and hippopotami) are partially or wholly devoid of enamel and grow from persistent pulps. The incisors also in the hippopotami grow from persistent pulps as in *Rodentia*. While the hyrax or coney and the rhinoceros have similar molars, the first resembles the rodents in dentition because of the larger size of its central incisors, which grow from persistent pulps, are chisel-edged, prismatic in section and furnished with a thick coat of enamel on their antero-external and antero-internal faces. The second pair of incisors which is small is soon lost. There are the full typical number of premolars and molars and the patterns of these teeth closely resemble those of the rhinoceros. In the lower jaw the middle incisors are small and the outer ones largely developed and all persist. Their crowns are trilobed and pass in ordinary closure of the mouth behind the upper incisors, where they are met by a dense pad of gum, but they are not of persistent growth.

The *Rodentia* are characterized by want of cuspid

teeth and by peculiar structure and great development of their incisors. The majority have but a single pair of incisors above and below. These teeth are large, curved and adapted to gnawing purposes by sharp, chisel-like edges, formed by the hard outer coat of enamel restricted to their front surfaces and wearing more slowly than the softer dentine or tooth core. These teeth during life grow from their roots as fast as they wear down at their tips. Should one be destroyed or diseased, the corresponding tooth in the opposite jaw,

Fig. 9.—Tooth of Hesperornis regalis, enlarged eight diameters. Marsh.

which ought to have been worn down by it, continues to grow until it may even bring about the death of the animal by preventing the mouth from closing and thus cause starvation or by curving over enter the back of the head.

An extinct order, *Tillodontia,* seems to combine characters of several distinct groups; *Carnivora, Ungulata* and *Rodentia.* The *Tillotherium* skull (Marsh, the type skull of the order) has the same general form as the bear, but in structure resembles the *Ungulata.* The molars are of ungulate type, the cuspids are small

and in each jaw there is a pair of large scapriform incisors faced with enamel and growing from persistent pulps as in rodents. The second pair of incisors is small and has not persistent pulps.

The *Insectivora* have small brains and small faces. Some approximate rodents and others the lemurs. The galeopithecus, which was formerly placed with the lemurs, forms one group. The other *Insectivora* are divided into two groups by the pattern of the molars. The majority present a W-pattern, while the others have narrower molars with a V-pattern.

The insectivorous bats have small incisors, rather large cuspids and molars which present the W-pattern.

The lemurs usually have the upper incisors very small and widely separated from each other. In the cheiromys, the incisors form a single pair of large curved teeth, growing from persistent pulps and wearing obliquely so as constantly to preserve a sharp cutting edge. The enamel is very much less thick, yet not altogther absent upon the backs of the upper incisors. The lower incisors are very narrow from side to side and very thick from back to front, are composed very largely of enamel, the dentine constituting but a small part. After considerable interval, which is devoid of teeth, there follow four upper and three lower teeth, which are not of persistent growth, but have definite roots and resemble the molars of many omnivorous rodents.

The *Simiadæ*, or true monkeys, are divided into the new and old world monkeys. The new world monkeys are divided into the marmosets and the *Cebidæ*, the marmosets. have only thirty-two teeth, unlike the others, which have thirty-six. They have three pre-molars on each side. The old world monkeys have this same dental formula as man. The anthropoid apes resemble man in their dentition. The *Simidæ* and *Anthropoidæ* (except a generalized type found by Ameghino in the tertiary of Paraguay, which has rodent, insectivorous and ungulate features) are identical as to pulp with man.

CONCLUSIONS.

In each order up to the primates occurs a difference in the size of the dental foramina, showing a struggle for existence between the organs.

In the evolution of the pulp from the placoid scales, the pulps are often many times larger than the scale.

Sauropsidæan pulps are generally as large, and sometimes larger than the tooth.

Shark teeth from their groove type have large pulps. The rooted part of each tooth is greater than the exposed and is hinged. The early teeth are formed in groups in place of sockets.

The formation of projections in the grooves of toothed birds and in some mammals show where change from open sockets to closed foramina of the teeth occur.

The variations which produce the toothless birds, the ornithorhyncus and the baleen whale to the lower dental types indicate that degeneracy in an organ which is for the temporary benefit of the type as a whole. The persistency of open pulps at the expense of the tooth as a complete type is an indication in the same direction. The relation between the dermis and the teeth as shown in pangolins, armadillos, hairy men and men with horny teeth, hairless dogs, etc., continues quite high in the scale, and is still to be reckoned with as a factor in pulp evolution.

When the dental blood supply is cut off and nourishment ceases, from the closing of the foramina, in man and some lower vertebrates, teeth virtually become foreign bodies.

Decay is therefore a natural process of excretion. When the teeth become foreign bodies, blood vessels approach but cannot enter them, hence they are blank walls where circulation ceases. The alveolar processes therefore are easily absorbed through metabolic change, causing interstitial gingivitis.

Since blood does not reach the enamel and dentine and nutrition is cut off, tooth decay is controlled by the trophic nervous system.

The pulp is, hence, still a transitory structure in human evolution, and hence one on which nervous and metabolic storm and stress exerts a strong play.

THE VASOMOTOR SYSTEM OF THE PULP.

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In 1733 Stephen Hales[1] first published the idea that small arteries changed their caliber. He devised the following ingenious experiment: Tying a brass tube into the aorta of a dog and employing a head pressure equal to the normal aortic tension he injected water and measured the outflow per minute from the divided vessels of the intestines. He found that cold water diminished the flow, while hot water increased it. He also showed (by the action of drugs) that one set of agents contracted the vessels and lessened the outflow, while another set widened the vessels and increased the flow.[2]

The chief dominating center of the non-striped muscles of the arterial system with motor nerves (vasomotor, vasoconstrictor, vasohypertonic) lies in the medulla oblongata. The nerves which pass to the blood vessels are known as the vasomotor nerves. Without mentioning the experiments which have been made, I might say, in a general way, stimulation of this nerve center causes contraction of all the arteries, resulting in great increase of the arterial blood pressure and swelling of the veins of the heart. Paralysis of this center causes relaxation and dilation of all the arteries, resulting in an enormous fall of the blood pressure.[3]

The sympathetic nerves consist of two chains of ganglia, one on each side of the spinal cord. Their function is to stimulate the viscera, glands, heart, blood vessels and unstriped muscles of the body generally.

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1. Statistical Essays, 1733, vol. xi.

2. A history of some of the experiments from this period to the present time may be found in Text-Book of Physiology of E. A. Schäfer.

3. Landois and Stirling: Human Physiology.

There are four small ganglia[4] connected with the fifth nerve: the ophthalmic, sphenopalatine, otic and submaxillary. Each has three roots derived from motor, sensory and sympathetic nerves, respectively, and varying members of branches of distribution. These cells are multipolar, thus resembling the cells of sympathetic ganglia and differing from those of the ganglia of the posterior spinal nerve roots and gasserian ganglion.

Each ganglion is a reddish-gray color, soft in consistence but enclosed in a strong fibrous sheath. It is connected above and below by an ascending and a descending trunk and with at least one spinal nerve by one or two communicating branches. Each ganglion distributes different branches which either directly or through the intervention of a secondary plexus supply blood vessels.

The second or superior maxillary division of the fifth

Fig. 1.—Nerve fibers torn from main nerve trunk and entering the canal through the apical foramen. x50.

pair of nerves gives off the posterior superior, middle superior and anterior superior dental nerves. These three nerves form a plexus and loops of filament which pass to the tips of the roots to form the dental pulp. The third division of the fifth, the inferior maxillary, a mixed sensory and motor nerve, enters the inferior dental canal, passing forward toward the symphysis menti supplying branches to the teeth and gums.

The gasserian ganglion receives filaments from the carotid plexus of the sympathetic. Connected with the fifth are the four small ganglia already mentioned which form the whole of the cephalic portion of the sympathetic. With the first division is connected the ophthalmic ganglion, with the second submaxillary ganglion. All the four receive sensitive filaments from the fifth, motor and sympathetic filaments from various

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4. Gerish: Anatomy.

sources. The ganglia are also connected with each other and the cervical portion of the sympathetic.

According to the "American Text-Book of Physiology," the vasomotor apparatus consists of three classes of nerve cells.[5] The cell bodies of the first class lie in sympathetic ganglia, their neuraxons passing directly to the smooth muscles in the wall of the vessels; the second are situated at different levels in the cerebrospinal axis, their neuraxons passing thence to the sympathetic ganglia by way of the spinal and cranial nerves;

Fig. 2.—Bundles of nerves in the pulp showing vasomotor system. Nerve fibers encircling an artery showing terminals. x50.

the third are placed in the bulb and control the second through interspinal and intercranial paths. The nerve cells of the first class lie wholly without the cerebrospinal axis, the third wholly within, while the second is partly within, partly without, and binds the remaining two together.

The vasomotor fibers for the face and mouth have

5. By "nerve cells" is meant the cell body, with all its processes, namely, the neuraxons or axis cylinder processes and dendrites or protoplasma processes.

been found in the cervical sympathetic by Dastre and Morat, leaving the cord[6] in the second and fifth dental nerves and uniting (at least for the most part) with the trigeminus by passing, according to Morat,[7] from the superior cervical sympathetic ganglion to the ganglion of Gasser and thence to the fifth nerve. The nerves of the cerebrospinal system, with the exception of the olfactory, are medullated nerves.

The vasomotor nerves are axis cylinder processes of the sympathetic ganglion cells. They follow for a

Fig. 3.—Bundles of nerves in the pulp showing the vasomotor system. Crossing of nerve fibers from one bundle to another. These extend along and around blood vessels. Degeneration tissue at lower border. x50.

time the course of the corresponding spinal nerves. Intermingled with the medullated fibers are always found gray or non-medullated fibers. According to Schäfer,[8] these fibers frequently branch; the medullated fibers rarely do except near their termination. The sympa-

6. Dastre and Morat, 1884, pp. 110-120.
7. Morat, 1889, p. 201.
8. Essentials of Histology, p. 118.

thetic nerves are largely made up of these fibers as they approach their peripheral distribution and possess a thin medullary sheath.

From what has been said it will be seen the intimate relation of the fifth nerve is as a motor nerve in mastication and a sensory nerve to the great surface, both external and internal, which belongs to the face and the anterior part of the cranium. From its great size and the large portion of the medulla with which it is con-

Fig. 4.—Bundles of nerves in pulp showing vasomotor system. Nerves around a crosscut artery. Y-shaped artery in center showing terminals. x50.

nected, there can be no question but that its sympathetic and vasomotor connection is established.

The nerve trunks as they pass through the lower jaw are made up of nerve fibers gathered together into bundles or funiculi, held together by connective tissue and called the perineurium. The connective tissue which unites a number of the bundles or funiculi is called epineurium. The cut ends under the microscope resemble very much the end of an ocean cable; the wires

representing the nerve fibers, and the rubber covering the connective tissue sheaths.

From this nerve trunk smaller medullated nerve fibers are given off at the nodes of Ranvier which pass up and into the apical foramina of the roots of the teeth. Sometimes there are two and again three or ten to twenty-five nerve fibers entering the foramina. The number depends on the size of the opening. In

Fig. 5.—Bundles of nerves in the pulp showing the vasomotor system. Five arteries with nerve fibers running lengthwise, also cross and long section of artery with nerve fiber around it. Thickening of arterial walls showing terminal nerve fibers. ×50.

my paper last year on "The Evolution of the Pulp" I demonstrated that in animals whose teeth were in continuous eruption during the life of the animal the pulp was larger at the opening than in the pulp chamber. In ascending to man the second teeth have small openings, especially later in life. In the very nature of things as the root calcifies, especially in exostosis, the

openings grow smaller. The number of nerves entering the foramina, then, will depend on the size of the apical opening.

In a general way, the motor, sensory and the sympathetic nerves have been traced from their source to the roots of the upper and lower teeth. Text-books demonstrate the peripheral end organs to other structures of the body. In no case (to my knowledge) has the character of the nerves of the pulp been demonstrated.

At the meeting of this Section last year Dr. Vida A. Latham, in a paper, "Résumé of the Histology of the

Fig. 6.—Bundles of nerves in pulp showing vasomotor system. Nerve extending along the arterial wall. At right angles may be seen the muscular coat of an artery filled with terminal nerve fibers. ×60.

Dental Pulp," showed the nerve supply to the pulp in different forms and also one illustration of the vasomotor system of the pulp. Part of our special work in the laboratory this year has been to demonstrate the character of the nerves of the pulp.

Pulp study has been conducted by Dr. Latham and myself in different laboratories for the past four years. For this work teeth have been collected each day to the number of over 4,000. These have been cracked open and over 2,000 specimens of pulps have been placed in different fluids ready for cutting, staining and mount-

ing for the microscope. All the different methods of preparation of nerve tissue have been used as reported by Dr. Anderson in a paper, "Notes on Pulp Technic."

The nerve fibers, after leaving the main trunk in the jaw, evidently enter the apical foramina in single nerve bundles. In many cases, these nerve bundles continue the entire length of the pulp without branching. On the other hand, the branching in many cases begins after the trunk nerves have passed through the apical foramina. In Figure 1, when the tooth was extracted

Fig. 7.—Bundles of nerves in pulp showing vasomotor system. Crosscut section showing ends of nerve fibers, also nerve encircling crosscut artery ×25.

the pulp protruded from the end of the root, the opening being large. In this illustration the nerve fibers are shown from the inferior dental nerve extending through the apical foramina in the root canal of the tooth. These seem to run in a bundle or funiculi with the exception of one fiber which is isolated at the root. Figure 2 shows bundles of nerve fibers loosely arranged running in different directions. Between these bundles may be seen many single nerve fibers running in all

directions. In the center of the field is an artery cut crosswise with terminal fibers encircling it two-thirds around. Figure 3 beautifully illustrates the vasomotor nerves in their relation to the blood vessels. The blood vessels and nerves run in the same direction. In the center of the field may be seen four arteries. Nerve fibers are notably running the entire length between, but they cross and recross at different localities. Nerve fibers in bundles and singly cover the entire field. Figure 4 shows bundles of fibers with many single fibers throughout the field. In the center may be seen an

Fig. 8.—Bundles of nerves in the pulp showing the nervous system. These nerves extend to the odontoblastic layer. Small fibers running below and to the odontoblasts forming a nerve plexus. x50.

artery cut lengthwise branching in two directions. The most interesting of all, however, is an artery cut crosswise with vasomotor terminal nerves encircling it. Figure 5 demonstrates the vasomotor system more thoroughly. In the center of the field may be seen nine arteries cut lengthwise and one cut crosswise. Bundles of nerve fibers run between the arteries and along the arterial walls. Nerve fibers are seen crossing and recrossing the arterial walls, sometimes in bundles and

again in single terminal fibers. In the cross-cut artery a nerve fiber may be seen almost encircling it. Figure 6 shows enlarged artery cut lengthwise, while just below it may be seen an artery running toward it at right angles. In this artery only the outer surface is seen. In both arterial coats terminal nerve fibers are well shown. Figure 7 shows the ends of the nerve cut crosswise. An artery may also be seen with a nerve encircling it. Figure 8 illustrates the crown end of the pulp with a bundle of nerve fibers which have extended intact the entire length of the pulp and is distributing its fibers throughout the odontoblastic layer.

In consideration that the blood vessels and nerves pass through the pulp in a wavy direction and not in straight lines, to have been able to obtain so many beautiful specimens showing so clearly and distinctly the vasomotor system is fortunate.

I am under obligations to Dr. Ludvig Hektoen for verifying these illustrations and to Dr. Martha Anderson for valuable services.

PULP DEGENERATION.*†

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There are two forms of pulp degeneration, physiologic and pathologic. The physiologic is along the line of evolution and under the general law of economy of growth or use and disuse of structures. Physiologic degeneration was discussed in a paper, "The Evolution of Pulp."[1] It was shown that structures nourishing the placoid scales were larger than the scales themselves. Later, in some sharks, toothed birds, elephants, etc., the circumscribed pulp is as large as the tooth; in the horse and cow it is smaller, while in the anthropoid apes and man the pulp grows smaller and smaller until, in adult life, the apical end is so small that only one or two small arteries and nerves enter the root of the tooth. I demonstrated the vasomotor system of the pulp with nerve endings in a paper on the "Vasomotor System of the Pulp,"[2] still later in 'Constitutional Causes of Tooth Decay."[3] I also demonstrated nerve degeneration and inflammation resulting in abscess of the pulp by disease of the body in connection with the vasomotor system and nerve degeneracy.

A pulp with such a record as I have demonstrated could hardly avoid pathogenic degeneration. Scarcely a pulp is exempt from influences of this, due to diseases of the body, external violence or pathologic changes. In the very nature of events, physiologic degeneration

* Read at the Fifty-fifth Annual Session of the American Medical Association, in the Section on Stomatology, and approved for publication by the Executive Committee: Drs. E. A. Bogue, Alice M. Steeves and M. L. Rhein.

† This paper is one of a series read before this Section for a number of years and was referred to in my paper on "The Constitutional Causes of Tooth Decay."

1. The Journal A. M. A., Aug. 2. 1902.
2. The Journal A. M. A., Dec. 19. 1903.
3. Dental Digest, December. 1903.

must necessarily result in pathogenic degeneration under the law of economy of growth and the struggle for existence between organs, influenced by bodily defects. Before taking up the different degeneracies, the nature of the pulp must be briefly considered.

The number of nerves, arteries and veins entering the apical foramina depends on the age of the individual and the tooth itself. A larger number enters early in tooth development than later in life, when the foramina is exceedingly small. Age and exostosis naturally reduce the size of the opening. Only one or two arteries enter the pulp chamber from the main trunk. These divide and subdivide, forming many branches and loops.

Because of the small opening at the apical end of the root, collateral circulation is impossible; hence, with end nerves and arteries, the pulp is an excellent illustration of an end organ. This constitutes its susceptibility to disease. The pulp enclosed within bony walls is without an opportunity for expansion in arterial dilation and sclerosis; it has only one or two small trunk arteries and veins for supply and waste. The blood likewise increases disease susceptibility. The vasomotor system makes the pulp to respond to any disease to which the general system may be subjected. Diapedesis follows. Thermal changes from without also modify the circulation of the pulp. Sudduth, and later Miller, are of opinion that there are no lymphatics in the pulp. If they be not present, still the pulp has great predisposition to degeneration, since Wedl, Tomes, Smale and Colyer and many others, as well as myself, have found large spaces, without walls, whose lymphatic nature has not been determined. That débris and waste products may be carried from the pulp through the veins seems probable.

One influence but little considered in relation to pulp degeneration or tooth structure in general, and one that exerts a marked consequence on tooth decay, is the factor of interstitial gingivitis, abrasion and erosion, which are degenerative conditions that take place at the fourth period of stress, at the senile stage or period of evolution at from forty to forty-five years of age. Not infrequently the senile stage occurs prematurely in neurotics and degenerates. At this period all excretory organs are weakening, faulty metobolism results, and the vasomotor system does not respond quickly. Marked disturbances take place in all the structures of the body,

including the alveolar process as well as the pulp. Wedl in 1872 first called attention to the senile condition of tooth structures shown by their discoloration.

Morbid change in the pulp other than nerve end degeneration, inflammation resulting in abscess, as already discussed, may be summed up as arterosclerosis, endarteritis obliterans, thrombosis and embolism, cloudy swelling, fatty degeneration, mucoid, colloid, hyaline, amyloid degeneration, pulp stones, neoplasm and fibroma. Some of these have been discussed by Wedl, Tomes, Smale and Colyer, Hopewell-Smith, Black, Boedecker,

Fig. 1.—Thrombosis of capillaries of pulp and inflammation (×187). Arteries and capillaries closed. Thrombus. Acute inflammation, showing there has been a hyperemic condition.

Arkovy, Andrews, Rómer, Morgenstein, Caush, Latham and many others, and can be studied more at length in the original monograph.

Here it is not my intention to study each morbid condition, but to show that the pulp is susceptible to them (individually and collectively), resulting in tooth degeneration.

Among vascular changes and circulatory disturbances, thrombosis in the blood vessels of the pulp is not uncom-

mon. From the present knowledge of pathology and the pathogenic condition of the pulp, it is evident how thrombosis must occasionally result. The pulp, an end organ without anastomosis and collateral circulation, the blood returning through a single vein, creates an anatomic predisposition for formation of a thrombus. The many degenerations and retrogressive changes which take place in the pulp make it susceptible to this morbid

Fig. 2.—Dilated vessel. Diapedesis and embolus. (×280.)

state. The spontaneous death of the pulp which sometimes follows disease can be thus accounted for. Formation of different calcic deposits causes the current to become slower and the leucocytes to be retarded in their progress from and to the apical end of the root canal. In time the blood plates separate from the blood current and are caught at the apical end of the pulp canal. Sudden blindness occurs under similar conditions. The ves-

sels become injured or abnormal, due to calcic deposits and other retrogressive changes and stasis take place, eventually furnishing a basis for future thrombosis and inflammation (Fig. 1).

A thrombus may be located in any part of the arterial system, but more especially the heart. Simple or septic fragments may become dislodged and carried through the blood streams to or into the pulp of the tooth. Having entered this cavity, its return is almost impossible.

Embolism consists of various structures, such as fat

Fig. 3.—The wall in one artery is thickened (endarteritis) and almost occluded by inflammatory products. In the smaller artery the intima contains round-celled infiltration almost occluding it. The pulp tissues show the myxomatous character very well, branched spindle and round nucleated cells in many places. (x225.)

drops, tissue fragments, tumor cells, air, etc. These follow the blood current. The size of the body regulates the distance to which an embolus may travel. It stops in vessels whose lumen prevents its passage. More frequently it is arrested at the bifurcation of the artery. The pulp is especially adapted for this purpose, since it is an end organ, with numerous loops terminating in one or more veins for exit.

Emboli, according to Hektoen, act in two ways, mechanically, clogging the circulation, and specific, depending on the nature of the embolus, whether infected or sterile, whether composed of dead or living cells, capable of further proliferation. The circulation may be mechanically obstructed. If septic material has lodged in a blood vessel, inflammation may extend to the surrounding tissues (Fig. 2).

Endarteritis Obliterans and Arterio-sclerosis.—Inflammation of the arterial coats in the pulp is very common. This is due, in a degree, to pulp embryogeny.

Fig. 4.—An enlarged artery in an early stage of thickening, the small vessels plugged up, well marked myxomatous pulp tissue. (×225.)

anatomy, environment and to its end-organ nature, as already stated. The diseases most commonly observed are endarteritis obliterans, arteriosclerosis. While it is not uncommon for each coat of the artery to take on a special type of inflammation, yet all frequently become involved.

Endarteritis obliterans is an inflammation of the inner coat of the artery, usually of a chronic type. The inflammation may arise from an irritant in the blood cur-

rent from the main current, through the vaso vasorum or through the lymphatics. The first is the most usual; in the alveolar process all three may occur. In the pulp, irritation in the blood stream is the most common method. Proliferation of the endothelium results. Bands of fibrous tissue develop. The blood vessels become obstructed and finally obliterated, impeding the circulation (Fig. 3).

Fig. 5.—Pulp stones scattered throughout, here and there a form of round-celled infiltration, longitudinal nerve trunks, few degenerated vessels surrounded by hyaline degeneration in the middle of nerve trunk. Early sclerosis and cloudy swelling or granular degeneration. Adontoblasts *in situ*. (x21.)

The structure pulp, made up of loops of blood vessels and situated within bony walls, with only one or two arteries and veins for the passage of blood, renders it a unique end organ, and its arteries susceptible to arteriosclerosis. This, together with endarteritis obliterans,

predispose the arteries to degeneration and necrosis. This is a thickening of the arterial walls, especially of the intima. It is secondary, according to Hektoen, to certain inflammatory or degenerative changes in the media. This is seldom observed early in life. It is commonly found after puberty, but more frequently at the senile stage, from forty years on. The causes producing arteriosclerosis in other parts of the body produce it in the pulp arteries.

The causes are usually auto-intoxication and drugs taken into the system, which likewise become irritants.

Fig. 6.—Fatty degeneration, acute pulpitis, sclerosis of nerves. Nerve degeneration, dilatation of vessels, faint outline of degenerated adontoblasts. (x187.)

Beside the distensive force and change in composition of the blood, local irritation on the arterial wall is an active cause. In diseases such as syphilis, gout, rheumatism, Bright's disease, alcoholism and chronic mercurial, lead, brass, arsenic and bromide poisoning, the walls become irritated, resulting in thickening of the arterial coats.

"The inebriate, whose brain and body after death exhibit a confused mass of wreckage, which the pathologist is often unable to trace back to the exact causes and con-

ditions, has, according to Crothers, always sclerotic conditions of the large and small arteries, together with atrophic and hyperatrophic states of the heart, kidneys and liver, with fatty degeneration and calcification of the coats of the arteries. These organic changes are so frequently present in inebriates that they constitute a marked pathology which is traceable to the use of alcohol."

Fig. 7.—Shows pulp stones and their close relation to the vascular channels. Dilated vessels with amyloid deposit. (x62.)

These irritants, acting through the vasomotor system and increasing the arterial pressure, finally cause paralysis and diminution of the caliber of the arteries and capillaries, producing stasis of blood (Fig. 4). This morbid state of the arteries tends to produce any or all of the other degenerations previously referred to.

The inflammatory process of the intima was first charged to direct irritation of material floating in the blood. Rokitansky and Thoma are of opinion that it is

secondary and dependent on the degenerative changes of the middle coat. This view I can not accept, since auto-intoxic states produce irritation in the blood streams.

Many degenerations of the pulp are the result of arterio-sclerosis, endarteritis obliterans and nerve degeneration. These degenerations occur in connection with each other; in other words, sometimes, two, three

Fig. 8.—Calcareous deposit, medullary nerve. Early connective cell formation. (×225.)

and even more are to be found in the same pulp. The causes producing these degenerations are not understood.

Retrogressive Changes.—One direct result of arterio-sclerosis and endarteritis obliterans is cloudy swelling and fatty degeneration. These conditions are observed in connection with such diseases as typhoid fever, septicemia and other acute infections and toxic diseases. The tissues present a whitish or shiny appearance, with-

out fibrous structures. Under the microscope the tissues present an opaque mass and do not take stain. The cells are quite large and swollen (Fig. 5).

"When a tissue, as for instance the heart muscle, receives a diminished quantity of blood on account of the narrowing of the lumen of the arteries due to thrombosis, embolism or disease accompanied by thickening of the intima, albuminous and fatty changing, remarks Hek-

Fig. 9.—This shows medullary nerve fibers and internodes, axis cylinders, myolin degeneration. (x280.)

toen, usually result. In the case of the different forms of anemias, degenerations with fat production are found in the liver, heart, kidneys and muscles. In such conditions there is not enough oxygen and other nutritive material to maintain the function of the cells. In actual starvation there is first absorption of all the fat in the body, accompanied by a marked diminution of the struc-

ture. In the later stages, albumin and fatty degeneration take place. Albuminal and fatty changes are very common in febrile diseases. They occur in practically infectious diseases and in a large number of the intoxications, such as the drug poisons. They are also found in abnormal metabolism, due to direct action of poisons and the abnormal process of oxidation." Owing to the pulp's peculiar structure and environment, fatty degeneration is commonly found in its tissue (Fig. 6).

Fig. 10.—Shows medullary nerve fibers slightly thickened. The connective tissue is degenerating and hyaline adontoblasts show well on both surfaces. (x156.)

Amyloid degeneration is a peculiar degeneration of the connective tissue, causing an albuminous substance to be deposited in the surrounding tissue. The walls of the blood vessels also become involved. It presents a shiny appearance and differs from other tissues in that it turns a dark red color with iodin. The morbid state is found in syphilis, tuberculosis, chronic dysentery, etc. (Fig. 7). Almost every structure in the body may be involved.

Hyaline degeneration (Fig. 8) is, according to Stengle, closely allied with amyloid, mucoid and colloid degenera-

tion, and all can pass into each other. It can occur in tissues during infectious and septic processes, following traumatism, in autointoxications such as drug poison, hemorrhages in cicatrices, in senile blood vessels, arteriosclerosis, endarteritis obliterans and in the nervous system. It can also occur in connective tissue which has undergone a change by inflammation. This morbid state

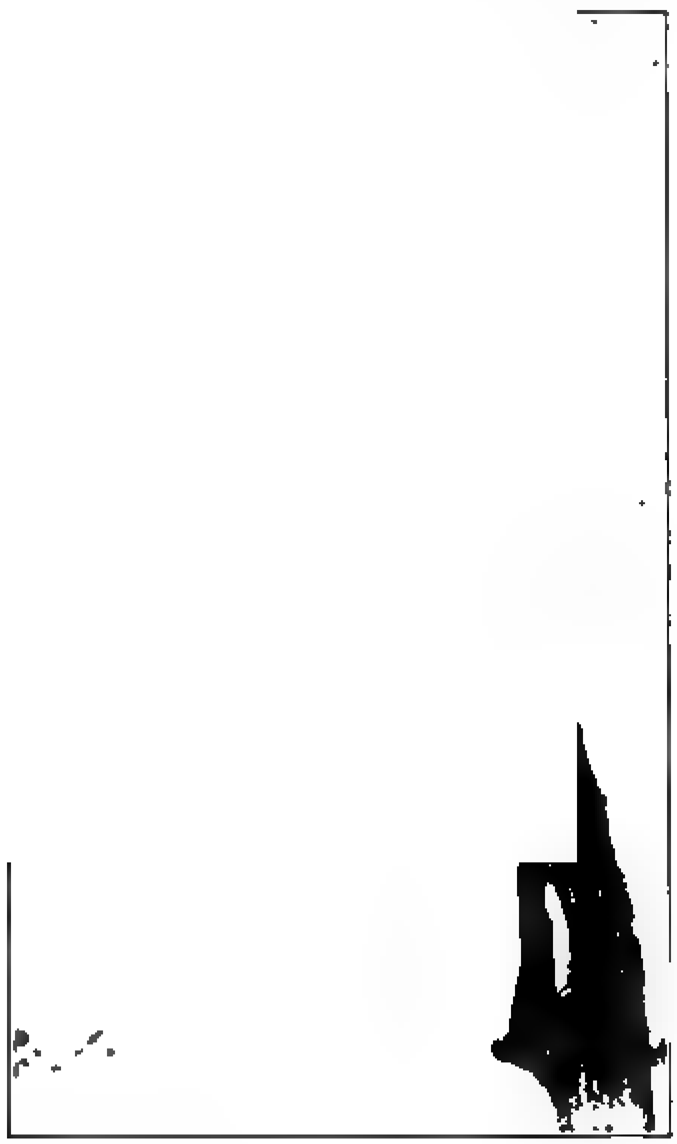

Fig. 11.—Shows interstitial fibrosis with acute inflammatory cells. Odontoblasts have been destroyed. (x22.)

depends for its action on local or general nutritive disturbances. The pulp, therefore, is susceptible to it. The intima, as well as the entire walls of the small blood vessels in the pulp, easily becomes involved. Some investigators believe that fat connective tissue cells so arrange themselves as to undergo a change into myaline substances (Fig. 9). These ultimately lead to calcifica-

tion. This raises the question of calcic deposits or so-called pulp stones. Pathologists know that tissues elsewhere in the body (which have necrosed or degenerated) are the localities where lime salts are deposited. Dying tissue which has undergone more or less change possesses, according to Ziegler, a kind of attraction for the lime salts in solution in the body. The tissues, to which attention has been called, are especially susceptible to calcic changes; hyaline and fatty degeneration, tissues involved in disease or drug poisoning, already mentioned here and elsewhere. Regions affected by slight degeneration and in structures like the pulp, a constricted end organ, are predisposed to deposits of lime salts. Calcic deposits have different shapes and location in the pulp tissue. Circumscribed structures appear solid under the miscroscope, to the naked eye or to the touch, are not pulp stones or calcic deposits, but in a large percentage of cases belong to other retrogressive changes. These deposits (Fig. 10) are, no doubt, due to degeneration of pulp tissue, especially in structures undergoing hyaline or fatty degeneration. Large masses of deposits in the form of spherules often occur. Bone formations are sometimes observed. These deposits, both in pulp stones and spherules, take on a dirty, bluish-violet color, with hematoxylin. These Dr. Latham and I have observed many times. Crystals may sometimes occur.

"This applies, however, as Ziegler remarks, only to deposits of lime carbonates and phosphates and not to those of lime oxalate." These deposits may take place at any time, but are most likely at the senile or fourth period of stress.

I shall not consider neoplasm at length in this paper, since Dr. Latham has this subject under discussion, but will only refer to fibroid degeneration in closing. Fibroid growth of the pulp may be both rapid or slow. Inflammatory reaction in fibrous pulps is rare, although when followed by infection or exposure, it may take place. Various degeneracies like those already mentioned are liable to occur, especially those in which connective tissue in general is predisposed. The fibers are observed in bundles, closely packed together, with many connective tissue corpuscles shown at intervals. Fibroid degeneration is easily distinguished from the other degeneracies of the pulp (Fig 11).

In these cases, the blood vessels and nerve tissue are relatively few. The blood vessels remaining usually have thickened walls, especially in the external and middle coats. This, of course, narrows the lumen. Not infrequently the blood vessels are entirely obliterated. These fibromas, very common in exposed pulps, are not now under consideration. In nearly if not all of these degenerations the blood vessels are first involved, later nerve tissue.

All these degenerations, including the pathologic processes of evolution, are the direct constitutional causes of tooth decay, erosion and abrasion brought about by diminution of tooth vitality.

CONSTITUTIONAL CAUSES OF TOOTH DECAY.[1]

BY EUGENE S. TALBOT, M. S., D. D. S., M. D., LL. D., CHICAGO. READ BEFORE THE CINCINNATI ODONTOLOGICAL SOCIETY, NOV. 27, 1903.

(Reprint from DENTAL DIGEST, December, 1903.)

It is my purpose here to direct attention out of the usual channels of discussion of tooth decay and to approach the subject by a different line of thought. Three decades ago, while pursuing research work among the neurotics and degenerates in this country and Europe I was struck with the rapid decay of their teeth. This made such an impression that I have since collected data from time to time upon the subject. Owing to the necessity of completing certain lines of research then laid out, this important subject could not be taken up in detail until within the past five years. This delay has been an advantage. Microscopic technique has so advanced as to now enable me to accomplish what would have been impossible earlier. Papers recently read by Kirk, Kester and Stubblefield have prepared the minds of the profession for the conception that there are other factors than lactic acid ferments. I am therefore relieved of the necessity of first demonstrating that constitutional factors influence tooth decay. In the study of disease two factors must always be considered—first, the tissues or soil; second, the bacterium or other cause. Most of the research work on tooth decay has dealt with bacteria or local causes, usually ignoring constitutional influences, soil or culture medium.

While, as Dr. Black states, there is no difference between soft and hard teeth so-called as regards the crushing force, still a vast difference in tooth structure from a physiologic and pathologic viewpoint exists as to vitality and decay. Teeth differ widely as

[1]Two former papers, "Evolution of the Pulp," read before the Section on Stomatology of the American Medical Association, 1902, and "Vaso-motor System of the Pulp," read before the same society, 1903, lead up to this paper.

to the quality of filling required. A tooth in its senile or pulp-degenerating stage resembles in tissue change a tooth in the constructive stage, so far as resistance is concerned. Having outlined the scheme of reasoning, some data collected in the past three decades deserve attention.

In any public institution for degenerate children the teeth will be found badly decayed. Teeth of degenerate children living at home decay faster than those of healthy children of the same family. Teeth of pregnant women decay faster than before pregnancy. At the senile period or the period of involution under mental strain teeth decay rapidly.

A forty-six-year-old woman had two sons and a daughter. The daughter at eighteen was attacked by peritonitis and died within a week. From persistent grief of the mother the teeth, previously in good condition, presented in eight months many cavities.

A forty-two-year-old woman was well-to-do financially. Her husband had charge of her property. She went abroad for two years and he was to bring her home at the end of that period. He failed to do so and kept her abroad for two years more. Remittances becoming short, she returned to find that her husband had squandered all her property, so she obtained a divorce. Resultant worry, as dermatologists would believe, turned her hair white. There was likewise marked recession of the alveolar process and gums from interstitial gingivitis as well as rapid decay of the teeth.

The teeth of a thirty-five-year-old woman became soft and decayed rapidly from deep grief over the sudden death of her husband.

Grief from its trophic results causes abrasion and erosion. The most marked cases are those occurring from death of husband, wife or children or loss of wealth. Drilling into pulp cavities of these types is often done without pain or hemorrhage; pulps are removed without pain and with little hemorrhage; marked changes take place in enamel and dentin; the tissues not infrequently become softened; the incisors break off near the gum under pressure. All of these states occur in neurasthenia and melancholia.

A forty-eight-year-old newspaper owner and editor became postmaster of a large city. Resultant mental strain produced neurasthenia, with interstitial gingivitis and rapid decay of the teeth. Here the teeth were normally hard as flint, the enamel cut with difficulty, the dentin was as hard as the enamel. When the extra

nerve strain was applied the enamel became brittle and the dentin cut like horn or old cheese.

Tooth decay occurs much more rapidly when neurasthenia is present, irrespective of the cause.

The teeth of paretic dements and tabetics decay rapidly. People who possess neurotic tendencies and inherited taint from consanguineous marriages or excesses suffer from tooth decay and irregularities. Severe illness will cause tooth decay and change the color to a dirty yellow, regardless of age, softening tooth structure. In hemiatrophy tooth decay and interstitial gingivitis occur on the affected side and perhaps to a lesser extent on the other. In heart lesions (fatty degeneration, valvular disease, etc.) decay is rapid. Syphilitic and tubercular patients have tooth decay and interstitial gingivitis, while tooth erosion, abrasion and discoloration also occur in relation to nerve disorder and disease.

The cutting or wearing away of the anterior teeth by the tooth brush below the enamel on the lower jaw and above the enamel on the upper is no doubt due to a softening of the dentin from systemic and internal causes. Such teeth are easily cut with bur, excavator or drill. Their pulps are less sensitive and bleed less than normal in removal.

A boy with sound healthy enamel after recovery from pelvic abscess complained of his teeth feeling gritty. Dr. P. J. Kester found that the enamel had disintegrated.

In typhoid fever the enamel becomes brittle and cleaves from about fillings and decayed edges. On the grinding surface of the teeth of those of middle-age, especially neurotics, the enamel wears away and the dentin is hollowed out as in erosion. Teeth which are soft with chalky enamel at one period may on the other hand become hard with organized enamel at a later period and stop decaying.

Dr. G. D. Boak states as to Philippine climatic effects upon the teeth: "While the weather is by no means as hot as it is at times during the summer in the States, the average temperature for the islands is about 89° F. It is a continuous heat without invigorating change of seasons. This gradually saps vitality and enervates, producing the lassitude which is characteristic of the tropics. Enervation produces anemia, with corresponding lessening of the resisting powers from the lower vitality, especially in those who have lived

previously in temperate climates. Caries is frequent and progresses rapidly in this climate." This Dr. Boak attributes to the following causes: First, lowering of the vitality by a lessening of the resisting powers; second, acidity of the oral secretions.

As DeMoor has shown, tooth decay under the law of economy of growth is a necessary phase of evolution. The jowllike face is going, and with it teeth pass from the megadont type to the microdont or some must disappear. A pathologic tendency to extend tooth decay beyond this often occurs. The spontaneous death of the pulp should be considered in this connection. Tooth decay is more common now than years ago. Teeth of Mound-builders, Cliff-dwellers and primitive races indicate this. Notwithstanding all the work that is done for the teeth, decay is greatly on the increase. It is more common in those who are advanced in civilization and brain development.

The work and results of Miller as regards the immediate cause of tooth decay may be accepted, as also the proposition that the teeth in public institutions as a rule are not kept as cleanly as in homes.

Study of the causation of tooth decay necessarily begins with embryogeny, histology and physiology of the structures. In "Evolution of the Pulp" I showed that the pulp was all-important for vital tooth existence, that the epithelial layer was a necessary factor, and that the alveolar process was a necessity after the tooth erupted. In evolution of the pulp from the placoid scale of sharks through its various stages to man there has necessarily been marked degeneration of it as a single structure for the benefit of the whole body, not unlike the vermiform appendix, ear muscles, short ribs, little toe, pineal body, etc., but to a more marked extent. Man's evolution in head bend and brain through the law of economy of growth has of necessity caused the jaws, alveolar processes, pulps and teeth to degenerate for the benefit of the organism as a whole.

The law of Aristotle (the struggle for existence between organs or the law of economy of growth), clarified and amplified by Goethe, 1807, St. Hilaire, 1818, must operate while life exists. The jaws, alveolar processes, teeth and their pulps are no longer supremely important structures for the existence of man. As such they tend to disappear under the law of economy of growth.

The teeth of man vary widely from their original type and function. Higher development from the lower vertebrates changes an

animal's surroundings and habits; therefore his structure and form must under the law of economy of growth be adapted to the new environment. In this evolution the head, face, jaws and teeth have undergone the greatest change. The fossil birds and reptiles had seventy-two teeth; some of the edentates have forty-two, while man reaches his highest physical development when he possesses thirty-two teeth. Man has not yet adjusted himself to his new environment. The jaws are still growing smaller and teeth are still disappearing—the third molar and lateral incisor for instance. In certain systemic conditions other teeth are lost and not infrequently no teeth develop. Not only are the jaws growing smaller but the alveolar processes are growing longer and thinner, which in turn reduces the vitality and support of the teeth. Interstitial gingivitis results and absorption of the alveolar processes takes place. In the natural closing of the foramina of the teeth nourishment to a great extent is cut off and decay easily attacks them or they drop out. By other methods also does the law of economy of growth rid man of useless organs. Decay is, however, a much faster method and in line with present environment. It may therefore be a normal process along the line of the law of economy of growth whereby a structure or organ is lost for the benefit of the organism as a whole. It is often a national tendency rather than a local one.

Embryogeny of these structures is governed by the same laws as other structures. As I have shown in "The Stigmata of Degeneracy" (The Medical Examiner and Practitioner, March, 1902), the brain early develops at the expense of other organs. Between birth and the third month the brain is one-fifth the weight of the body; in the adult it is one thirty-third; during the first six months it doubles in weight. Since the brain presides over development of the tissues of the body through its trophic and vaso-motor systems it must be as fully developed and normal in construction as possible so that body tissues may develop normally. Pleasure, happiness and laughter aid digestion, while melancholia and grief may retard growth and function and produce tropho-neuroses. An unstable nervous system produces unstable tissues, i. e., either excessive or arrested.

While the nervous system has other special functions, the one great object is that of regulating growth and repair. As Marinesco has shown, this function resides even in the neuron or nerve unit.

Growth and repair are regulated through the trophic and vaso-motor systems. In the domain of bone growth, trophic nerve anomalies were first observed. Brown-Sequard demonstrated anomalies in tabetic joints of sufferers from locomotor ataxia and later similar states were observed in the jaws. Another allied neurosis, paretic dementia, presents similar trophic disturbances, as Kiernan pointed out twenty-five years ago. (Journal of Nervous and Mental Diseases, 1878.)

Among these tropho-neuroses is one characterized by loosening and falling out of the teeth by alveolar resorption, gingival ulceration and perforation, with at times maxillary necrosis. This condition has long been recognized by alienists and neurologists as causing that loss of the teeth which occurs in paretic dementia, locomotor ataxia and diabetes. This function of the trophic nerves, as I have elsewhere shown, has received but little attention from dentists, albeit its influence has been recognized in dental pathology in connection with the great neuroses in which gum disorder occurs, followed by the loosening of the teeth.

Degeneration of the peripheral nerves due to interruption of the connection with the central nervous system was first shown by Nasse and Valentine in 1839. Not until 1850, however, was a thorough study made of nerve degeneration by Waller, the pathology of which is now known by his name. Wallerian degeneration implies change in the terminal ends of the peripheral nerves after they have been cut, which consists in coagulation or breaking up of the myelin sheath, destruction of the axis cylinder, the neurilemma with its nuclei remaining for some time preserved. (The Nervous System. Barker.) If a sensory nerve be cut through peripheral to the spinal ganglion complete degeneration ensues.

Similar experiments showed that if the dorsal root of a spinal nerve be cut through at a point between the ganglion and the spinal cord the portion of the nerve attached to the ganglion did not undergo the typical degeneration, while the portion still connected with the cord showed the characteristic degeneration phenomena which could be traced throughout the whole course of its constituent fibers in the dorsal funiculi of the cord. The cells of the spinal ganglia have therefore been looked upon as trophic centers for the peripheral sensory nerves and their intramedullary continuations.

Similar degenerations in the domain of the central nervous sys-

tem likewise occur; secondary descending degeneration of the pyramidal tract, established by Turck, and ascending secondary degeneration in the spinal cord after transverse lesion being analogous.

Converting then, as Barker remarks (Ibid.), the Wallerian doctrine into terms of the neuron concept, the following general law may be laid down—"Whenever it has suffered a solution of continuity, with severing of its connection with the cell body and dentrites of the neuron to which it belongs, the axon, together with the myelin sheath covering it, undergoes in the part distal to the lesion acute and complete degeneration. This degeneration includes not only the main axon but also its terminals, together with the collaterals and their terminals connected with it."

Some investigations have shown that the slightest injuries to nerve cells or neura will give rise to easily demonstrable degenerative lesions in other parts of the cell. The most significant instance is in lateral sclerosis, where the pyramidal motor cells of the cortex show no marked lesions, though the most distal portions of the nerve fibers arising from them have gradually degenerated.

In some peripheral nerve diseases, according to Strumpell, the degeneration of the distal portion of the axones may be due to direct action of toxins exerting a deleterious influence upon the cell body or the whole neuron. In Wollenberg's opinion the primary type of disease of the sensory neura in tabes is of this kind.

As Sydney Kuh (American Medicine, Vol. III, No. 21, Pages 865, 868) has shown, in some of the toxic forms, as for instance in neuritis due to poisoning with lead and arsenic, the cells of the spinal cord as well as those of the spinal ganglia and brain may be diseased, and according to the neuron theory the toxic substances attack these cells before the nerve fiber itself is altered. Such an assumption explains why pronounced degeneration of peripheral nerves may occur without causing any appreciable symptoms. Pitres and Vaillard first showed that after typhoid fever many nerve fibers are found degenerated in cases where during life symptoms of neuritis were absent. The same observers found like states in the nerves of those who had died from tuberculosis. Later observations have extended these states to such diseases as diphtheria, syphilis, alcoholism, carcinoma, inanition, marasmus, arterio-sclerosis and leprosy; in the so-called rheumatic neuritis of the facial nerve and to

inflammation due to articular rheumatism, gout, puerperal infection, tuberculosis, etc.

The method of cell poisoning has been observed in other intoxications. (The Nervous System. Barker.) Certain groups of neura are more susceptible than others to a given toxication. The same group of nerve cells in two individuals may react very differently to similar doses of the same poison. Syphilitic toxin shows a decided preference for certain parts of the cerebral cortex, other areas being less affected; the nerve endings in all parts of the body are markedly involved, especially those in and about the teeth. Peripheral nerve degeneration results where the blood current or the nerves themselves are involved from faulty metabolism, etc.

Nerve lesions more readily result where nerves are confined within restricted walls of transitory structures where the pulp has degenerated, especially in cases of hypercementosis of the root. When degeneration of the peripheral nerves in the pulp takes place there may at first be pain, continuously perceptible to the patient or absent except under manipulation or replaced by analgesia. In most cases there is analgesia, owing to the peculiar anatomic construction of the tooth and nerve degeneration. There is a loss of function. When degeneration sets in there is no pain either in the dentin or the pulp itself. This is peculiarly noticeable in drilling through dentin into the pulps of syphilitics, tubercular persons, tabetics, paretic dements, and those suffering from drug poisoning. This peculiar lack of pain sensibility may occur when the enamel is defective and the dentin has turned a dirty yellow. Teeth with defective or no enamel, and cutting like horn, may be manipulated without pain. Not infrequently the pulps can be removed alive and without pain in persons who have had protracted illness. The nervous system loses its resistance and disease easily runs its course. This is why so few degenerates survive. It is also a reason why their teeth decay so early and readily. Defectively-formed enamel, interglobular spaces, and a want of resistance are fruitful soils for germ diseases or decay.

The checking effect of a disordered nervous system upon the jaws, alveolar process and teeth in their embryogeny is not unlike that exerted upon other structures. Marked illustrations are cases where teeth develop without crowns or enamel, or the structure be like horn, or where the epithelial layer becomes arrested and pits and grooves are seen in the enamel. The effect upon the structure of the

enamel and dentin has been shown by Andrews, Black, Williams, Tomes, Hopewell-Smith, Allen, Sudduth, Latham and many others. Not only are there interglobular spaces but faulty structure results. Indeed, so common is this the case that hardly a tooth is exempt. Scarcely anything different could be expected when it is remembered that the teeth are degenerating structures and that there is rarely a normal pulp.

Arrest of development in the upper jaw is more common than in the lower, owing on the one hand to the upper's fixed attachment to the other bones of the skull under the law of economy of growth, and on the other hand to the mobility of the lower. Hitchcock, Magitot and others have found decay of the teeth more frequent on the upper than on the lower jaw. The checking influence of the nervous system which produces arrest of development of a jaw bone must affect the embryonic structure of the teeth, hence more frequent decay upon the upper than the lower. Decay of the teeth is more common in arrested jaws where the teeth are irregular than in well-formed jaws and teeth. The lower jaw being movable, more blood is sent to the part and the bone is less liable to become arrested. The same explains why there is less decay of the teeth upon the lower jaw, as the vitality of the structure is greater. Arsenic applied to the periphery of the dentin will reach and destroy the pulp.

When the pulp is destroyed there is no more sensitiveness on the periphery at the neck of the tooth, or where the enamel has been removed, showing that nerve sensation extended through the dentin when the pulp was alive. Teeth are sensitive to excavation, but not when the pulp is destroyed. When the pulps have been destroyed the cement substance which holds the enamel rods together loses its tenacity and the rods cleave readily apart, the dentin cuts much easier and decay is more rapid. Quite an odor from the decomposed animal matter in the tubules of the dentin is observed when cut either with an excavator or bur. If a tooth that has been removed on account of interstitial gingivitis be cracked open the odor is loathsome although the pulp is alive. The substance in the dentin must therefore give vitality to the tooth.

In the struggle for existence, owing to the changes which are taking place in the jaws and teeth at the expense of the brain, the trophic nerves are not directing nutrition to these parts, the result of which is degeneracy in structure.

The pulp reaches its highest physical development and is at its normal size when it commences to form dentin. This is the highest normal period in lower vertebrates with open foramina. It degenerates from this period and never after recovers its normal physical condition. There are, according to Sudduth, Miller and others, no lymphatics in the pulp, it being a formative as well as a degenerative organ. The dental pulp is an end or terminal organ. No tissue in the human body is so completely without anastomosis. It is made

Fig. 1.

up of loops of blood vessels and nerves, virtually terminal structures, with a minute outlet which renders it a degenerate type of organ, like the alveolar process and all end structures, easily diseased. On the assumption that the dental pulp is the basis upon which the tooth develops and in a great measure obtains its nourishment and vital resistance, special investigations have been made by Dr. Vida A. Latham and myself with a view of studying its development, function and physical condition, which are not yet completed.

Starting with the proposition that evolution of the pulp from the placoid scale to its present state in adult life is a physiologic degeneracy, it is not difficult to trace pathologic degeneracy, since I have already demonstrated its vaso-motor system. Degeneration of the nerve endings must now be shown. For the purpose of studying this subject teeth have been collected, cracked open, and the pulps placed in different fluids for cutting, staining and mounting. Many methods and stains have been used. Stains that have proven successful on nerve tissue in other parts of the body do not work well

FIG. 2. x 143.

or uniformly on pulp tissue, for owing to its unstable and degenerate nature the structure is rarely twice alike. Much care and attention are required to obtain good results.

It was thought best to incorporate the methods used in a separate paper for handy reference, hence I shall from time to time refer to the formula, and those interested can verify the results if so desired.

Figure 1 is a picture (partly schematic) showing Wallerian degeneration of nerve fibers after section. Thoma. 1, normal nerve

fiber; II and III, fibers showing different degrees of degeneration; S, neurilemma; m, medullary sheath; A, axon; k, nucleus of neurilemma cell; L, marking of Lantermann; R, node of Ranvier; mt, drops of myelin; a, remains of axon; w, proliferating cells of neurilemma.

Figure 2 shows one of the main nerves of the pulp, extending to the center of the picture, when it branches into two distinct trunks. An artery faintly outlined may be seen behind the nerve trunk which also bifurcates like the nerve. The vaso-motor track is well marked

FIG 3 x 162.

by the circular coat of the vessels being cut in such a way as to show the outer walls running parallel with the nerve trunk. The single vessels show the corpuscles plainly. The trunk nerve consists of a number of medullated nerve fibers. Internodes can be plainly seen in some of them. In some of the nerve fibers varicosity or Wallerian degeneration is plainly seen. Internodes or Ranvier's nodes are also plainly seen. The basal structures in these pictures are seen only partially or not at all, since they are stained specially to bring out the nerve fibers.

Figure 3. The nerve trunks show the medullated character very well, many nodes of Ranvier being in evidence. Varicosities and various degrees of degeneration can be followed in the individual fibers. In a few fibers the darker axis cylinders with a higher stained primitive sheath are also seen. The various coats of the artery show the nuclei cut in transverse or vertical directions.

Figure 4. The nerve fibers in this picture present a much more swollen and thickened appearance than in Figures 2 and 3. The nuclei of the fibers show clearly and also varying degrees of thick-

Fig 4. x 156.

ening. Some fibers show drops of myelin or Wallerian degeneration. The upper bundle of fibers has become thickened and sclerosed. The basal structure with connective tissue fibers and cells is better shown than in the other pictures.

Figure 5. In this picture appears a large nerve trunk much increased in size and ending almost abruptly like a neuroma in an amputation. The basal structure is very much altered, being of a chronic interstitial variety. There are few if any connective tissue cells but well marked bands of fibrous tissue. The individual fibers

of nerves show interruptions by the intermixing of the fibrous stroma, thus interrupting their function. The fibers are varicosed and vary in thickness.

In a previous paper I demonstrated the vaso-motor system and nerve endings in the arteries of the pulp. This, nerve-end degeneration, and the blood are the three sources by which any and all diseases and poisons of the body may affect the pulp and thus lessen the resistance of tooth structure.

Owing to the peculiar shape and location of the pulp, the small

Fig. 5. x 143.

capillaries and thin walls, external irritations increase the blood pressure in the small capillaries and veins enough to cause rupture without the aid of vascular changes, especially in cases of marked obstruction.

If the overflow of the venous blood in a given vascular area be totally interrupted, diapedesis of the red blood corpuscles from the involved capillaries and veins starts up, which is a result of the local increase in intravascular pressure.

The exodus of blood corpuscles through vascular degeneration occurs particularly after mechanic, chemic and thermal lesions of

the vessel walls, certain poisons also affect the vessel walls with especial virulence. Claude Bernard's experiments show that dilations of the vessels follow paralysis of the local ganglia in their walls, while a disease like diabetes produces vaso-motor neuroses upon end organs.

Vaso-motor constriction of the pulp causes pure arterial hyperemia. Arterial dilation and redness are produced by constitutional disease or constriction at the apical foramina. As a result of this dilation

Fig. 6. x 59.

the blood current meets with less resistance in the pulp chamber, and a greater amount of blood flows into it. The pressure of the corresponding capillary rises, as the blood remains under greater pressure on account of the diminished peripheral arterial resistance. In this manner capillary and venous pulsation so frequently noticed in the teeth is brought about. There is no part of the body in which local hyperemia is so apt to occur as in the pulp, since constriction is always present.

Active hyperemia produces swelling of the pulp tissue, and on

account of its restricted space within the walls of the tooth the pulp cannot expand, and as there are no lymphatics debris cannot be carried off. The serum of the blood transudes into the tissue, and there being no collateral circulation death of the pulp must follow.

Local anemia or ischemia may result from lack of blood supply in the pulp either from constriction, disease, thrombosis of the arteries or the nerves at the apical end of the root, due to disturbance of the vaso-motor system.

Narrowing of the arteries increases the resistance of the current

Fig. 7. x 156.

and the blood reaches the capillaries in the pulp under a very low pressure. This causes them to contract, and the area of the surface is materially diminished. End or terminal arteries like those in the pulp supply a definite organ or portion of the body and have little or no anastomosis with other branches. These are found in the spleen, the kidney, and certain parts of the brain and retina.

When local anemia resulting from constriction of a terminal artery occurs, as at the end of the root of a tooth, or as a result of

dilation due to the vaso-motor system; death of structure or organ takes place by coagulation, stagnation, neurosis or thrombosis.

When circulatory disturbances arise stasis takes place. When, according to Hektoen, the capillary loses all its plasma, as in local anemia, inflammation results from constriction due to the vaso-motor system, thereby closing the apical end of the root of the tooth. Vaso-motor disturbance producing or accelerating inflammation has often been shown, therefore I shall not enter into a lengthy discussion of it. It is enough to say that any disease or action of the vaso-motor system upon terminal structures (like the pulp) without lymphatics, constricted at the apical end and enclosed in bony walls, is very apt to produce or hasten inflammation.

The evolution, embryogeny, physiology and pathology of the pulp make it very susceptible to inflammation. Inflammation may result from external causes, the action of the vaso-motor system, nerve-end degeneration, or blood disorders. The external causes will not be discussed in this paper. Inflammation may occur at any locality in the pulp. I have previously observed an area of inflammation located at the horn at the center of the pulp and also in the apical end. The inflammatory process may pass through all the stages to pus infection and abscess without pain to the patient. This may be due to nerve atrophy, degeneration, or sclerosis, foramina constriction, or ganglion degeneration. It may be due to changes brought about in the vaso-motor system of the pulp. Tomes, Salter, Wedl and Harris all find that pulp inflammation may occur without exposure.

Black (American System of Dentistry) takes the student through the different processes of inflammation, where there is exposure of the organ. The same process results in inflammation of the pulp, except that the cause is internal instead of external. Whether resolution takes place or not will depend largely upon the vaso-motor system, and the size of the apical foramina to allow for circulation.

Figure 6. In this section of the pulp from a molar there are in the crown some large cells (myeloid) and pulp stones, which, by much irritation, have caused inflammation on one side even to abscess formation, vessel dilation and excess of red-cell infiltration. The other side is comparatively healthy, but has the round-celled infiltration showing in its very earliest condition. One, the smallest, just beneath the odontoblast layer, with well marked nerve fiber just beyond. A second, still further towards the center of the pulp

on the other side of it, shows a large nerve trunk, even the internode being visible in the low power, and just above it an area of nerve degeneration. Still lower down a darkening area is to be seen, showing a ruptured vessel, a large number of round cells with a small vessel or capillary shaped as a Y branching across a continuation of the lower nerve trunk. Degeneration in various stages is well marked.

Figure 7 shows a similar condition to Figure 6. This area was just beneath a coronal abscess with necrosis. Cells were pushing

FIG. 8. x 67.

into the connective tissue stroma and involving the arteries in some places. Just below one of the vessels cut nearly to the endothelial coat is a circumscribed abscess, one of a series of multiplying abscesses which occur all through the specimen. The special nerve staining renders it a difficult matter to bring out all the cellular detail, but same can be well understood under the microscope.

Figure 8 is a cross section of pulp with very early localized round-cell infiltration just beneath the odontoblasts. The pulp shows a slight increase in connective-tissue cells all through it. Numerous

nerve trunks are scattered here and there both in cross and oblique sections.

Figure 9 shows a further stage of Figure 8 with some cloudy swelling, coagulation and a slight central necrosis situated beneath and to one side of the odontoblasts. Fibrous or interstitial pulpitis is well seen further under the abscess, with considerable fatty degeneration at one end. Figure 10 is a very advanced sequela of inflammation occurring near the coronal portion of the pulp. Above

Fig. 9. x 67.

the part photographed the tissue has fallen out from necrosis. There is a well marked necrotic area with considerable round-cell infiltration. Some cells take the hematoxylin stain very well, many of them, polynuclear leucocytes and others, hardly take it at all. Some attempts at fibroid tissue formation can also be seen, forming a trabeculæ for the cells in places. There are also a few very small pulp stones.

Figure 11 is even further advanced than Fig. 10. The whole of one horn is entirely inflamed and rapidly terminating in suppuration

and necrosis. Many cells are in a state of parenchymatosis degeneration. Between strands of fibrous tissue, thickened and sclerosed nerve trunks, there are a very few small pulp stones around one end. On the further horn the odontoblasts are faintly outlined. In one spot there is a very small localized abscess, well marked round-cell infiltration, beneath the pulp is nearly normal, only a slight increase in odontoblasts. Passing down towards C another abscess and a liquefying area appears, and to the outer odontoblastic zone a scler-

FIG. 10. x 131.

osed nerve (e) in a hyalin fibroid tissue; the odontoblasts are no longer to be seen, their nutriment basement layer has fallen away at the lower part, a few again appear towards the cervical pulp as normal odontoblasts, but under same and deeper in the tissue is some fatty degeneration with a fibroid root portion of the pulp.

Figure 12. The interest of this photomicrograph lies in the fact that the abscess is situated midway of the curved part between the bifurcation of the roots. The whole pulp is filled with a greatly increased cell infiltration, especially in Weil's layer beneath the odon-

toblasts, the latter being granular in appearance. All the blood vessels are swollen and filled with a hyalin coagulation. A granular amorphous debris is seen everywhere through the basic substance of the pulp.

Figure 13 illustrates the extreme apical end of the pulp. One horn of the crown end is entirely destroyed by an abscess; the other horn is healthy. The nerve fibers are well stained. Passing down is a narrow area, slowly changing to a condition of atrophy. Below this the tissue seems to be in a healthy condition. As we pass down

FIG 11. x 29.

toward the apex several small areas of round-cell infiltration may be seen, forming abscesses similar to Figure 6. The extreme apical end is shown in the picture, poorly-stained areas (cloudy swelling). some small fatty areas, trunks of degenerating nerve fibers. A suppurative area among the fiber and blood vessels with necrosis at the tip of the pulp apex. An artery cut across with thickened walls may also be seen at the left of the picture.

Neurasthenia is a common neurosis by which Preston remarks males are equally affected with females. It is a nerve instability in which in addition to ordinary nerve fatigue there is a morbid

susceptibility to emotions and inability to restrain their manifestations. It is apt to make its onset near puberty when permanent teeth are most liable to decay. Temporary teeth are frequently badly decayed as a result of child neuropathy and hysteria. Permanent teeth later in life decay from premature senile neuropathy. Neurotic inheritance aided by the influence of climate and race tendencies, and an unstable, badly organized or imperfectly developed nervous system, are potent factors in tooth decay. When to this are added diatheses like tuberculosis, syphilis, etc., causes for tooth decay are

Fig. 12. x 55.

enormously increased. Any long-continued disease, grief, fear of litigation or death, also cause nerve fatigue, an excessive nerve waste and its retention. Anxiety, especially of young children, and between the ages of twelve and twenty-four, relative to their standing in school, is a fruitful source of nerve tire, nerve waste, and faulty metabolism. The forcing system of schools adds neurasthenia to the lists of accomplishments. While "all work and no play makes Jack a dull boy" from nerve tire and self-poisoning, the same is even more true of Jack's sister. Few universities do not have in their faculties

fairly typic neurasthenics from pedagogic worry and too one-sided life.

The causes just enumerated are in adults fruitful sources of nerve exhaustion. Elsewhere I have frequently shown that any excess is a fecund cause of nerve exhaustion. Neurasthenia occurs in every walk of life. People raised in luxury and idleness are the most evident victims of neurasthenia. Neurasthenia was particularly frequent among the second generation of Puritans, whence the

Fig. 13. x 50.

Salem witchcraft epidemic and the miraculous cures related by John Eliot. The lowest classes who give free rein to the appetites and the tramps are often neurasthenics, as are those between these two, persons who lead a sedentary life to which is added severe mental strain, care, responsibility, monotony, anxiety. Neurasthenia is frequent among clerks, teachers, literary workers, etc. It is often the ancestral phase of degeneracy; through it occurs the rapid decay of the teeth in persons over thirty or forty years of age who have had very little decay previously.

The effects of disease upon the pulp of the tooth, both through exposure, nerve-end degeneration, and the vaso-motor disorder, have already been described. These morbid processes produce spontaneous death of the pulp or diseased areas, thus lowering the vitality in the tooth as a whole, or in circumscribed localities. Want of tooth resistance allows lactic acid ferment to make rapid inroads upon tooth structure which would not otherwise occur had the vitality remained normal. Where disease appears the excretions are

FIG. 14. x 143.

vitiated and thereby greatly assist in promoting local decay. Acid secretions of the gums in unkept mouths of neurasthenics and degenerates, mixed with lactic-acid ferment, act rapidly in producing tooth decay at the cervical margins. Want of tooth resistance due to vaso-motor disorder of the pulp or nerve-end degeneration, as a whole or in areas, aids wearing away of the teeth in erosion and abrasion.

The effect of systemic conditions upon the pulp through the vaso-motor disorder, nerve-end degeneration and neurasthenia is to

produce other degenerations such as cloudy swelling, fatty degeneration, mucoid, colloid, hyalin, amboid, degeneracy, endarteritis oblitcrans, pulp stones, secondary dentin, neoplasm and fibroma. These degenerations will be elsewhere considered under "Degenerations of the Pulp."

The question now naturally arises, "Does the pulp repair itself when injured or diseased?" Many have said that no lymphatics are to be found. Some state that no spaces are present. The natural impression is therefore that repair is impossible. In certain animals

Fig. 15. × 45.

the pulp undergoes repair. This is observed in the teeth of animals where the pulps are large at the foramina. Especially is this true in the pulps in the tusks of elephants and other animals. Lymphatics are, however, to be found in these pulps. While I have never been able to demonstrate lymphatics, oval spaces occur in many pulps, which spaces possess different sizes and shapes, some perfectly round but in most cases flattened upon the sides. They are without walls. Figures 14 and 15. Their exact nature is uncertain. It is true, however, that septic material and microorganisms are carried from the pulp into the glands of the neck. Dr. Korner Halle of Berlin

(Items) by an injection of Prussian blue into the tissue of the pulp proved that the particles could find their way from the pulp into the glands. He experimented upon dogs, by exposing the pulp, painting in Prussian blue, and cementing the cavity. Two or three days afterwards the dogs were killed and the pulps of the teeth as well as the submaxillary glands examined with the microscope. Particles of the Prussian blue were found throughout the pulp to the apex of the root and also in the lymph glands. This then should be sufficient proof that if lymphatic glands are not present nature has never-

FIG 16 x 450.

theless provided means for the care of the pulp in disease. That pulps do repair themselves by two methods, lymphatics or no lymphatics, is certain, however. Miller (International Dental Journal, September, 1903) mentions a case described by Gysi and records three cases with illustrations which have occurred in his own practice in which the human pulp after being diseased has thrown out secondary dentin and repaired tooth decay. The pulp was restored to health.

I shall here call attention to this beautiful illustration, Figure 16. At A, diseased pulp in which is seen a circumscribed area of acute

inflammation about to liquefy and form an abscess; C, a fully formed abscess, and B, the cicatricial tissue of an old abscess, showing conclusively that restoration of a diseased pulp is possible. Speaking of want of lymphatics in the pulp Miller says, "It is for this reason that an abscess or center of inflammation the size of a pinhead in the pulp of a human tooth may cause excruciating pain, while its presence on the surface of the body might escape notice altogether." This, however, is not often the case. I have shown that in neurasthenia, hysteria, degeneracy and many diseases the peripheral nerves lose their sensation and hence little or no pain is experienced. Lymphatics are not connected with sensation except as to relief of pressure, but nerve disorder readily interferes with transmission of pressure symptoms, necessary to constitute pain.

[Reprinted from April, (1905), numbers of ILLINOIS MEDICAL BULLETIN.]

The Illinois Medical Bulletin

(THE BACILLUS)

A MONTHLY JOURNAL OF MEDICINE AND SURGERY.

VOL. 5 APRIL, 1905. NO. 8

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CONSTITUTIONAL CAUSES OF TOOTH-DECAY, EROSION, ABRASION AND DISCOLORATION.

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(Read before Section II, Fourth International Dental Congress, St. Louis, Mo., August 30, 1904.)

Awarded Honorable Mention by the Committee on Prize Essays.

To Dr. W. D. Miller are due honor and credit *par excellence* for his masterly discovery of the local causes of tooth-decay. Unlike etiologic discoveries in other diseases, that of lactic acid, ferment but partially suggests prophylaxis. Indeed, despite treatment, tooth-decay is more rapid and widespread today than formerly; with each generation ushered into the world the ravages of decay increase. This being the case, what are the underlying factors influencing these conditions?

The underlying factors which are set forth at length in my paper entitled "Anatomic Changes in the Head, Face, Jaws and Teeth in the Evolution of Man," read in the Section on Anatomy, Physiology, Histology, and Microscopy"* comprise the phases of the evolution of the face, jaws and teeth. These are modified by neurasthenia and

*See *Dental Cosmos,* November, 1904, Vol. XLVI, p. 897.

faulty nutrition of one or both parents or the child, or of all combined. If this be doubted, let the skeptic compare his patients with children of similar ages in any school for degenerates in this or any other country, or compare healthy normal children with the degenerates of the same family. Naturally, the secretions of the mouth are vitiated by the conditions named, and the lactic acid ferment is assisted. Vitiated excretions, however, do not account for all facts in the following cases.

A woman, 22 years old, a lifelong patient, became pregnant. Her teeth, which had been in fine condition up to this period, decayed rapidly thereafter. Caries appeared around new fillings and many new cavities occurred within twelve months.

A girl of 14 years had her teeth put in order in September, 1903. She went to a preparatory boarding-school. She returned in June, 1904, with thirteen cavities, some around fillings, but mostly new ones.

A man, 46 years of age, a broker, had sound, healthy teeth, with few fillings, until an attack of nervous prostration consequent on business strain occurred, when his teeth decayed rapidly, softening so that the enamel could be removed like leather.

A minister of 38 years with a fine set of teeth, broke down in health from overwork. After three years' absence in France he returned to America with every tooth decayed, twenty-one of his teeth having to be crowned.

A woman of 46 years had two sons and a daughter. The daughter at 18 was attacked with peritonitis and died within a week, thereby plunging her mother into deep depression. The mother's teeth, previously in good condition, presented in eight months many cavities.

A woman of 42 years was well-to-do financially; her husband had charge of her property. She went abroad for two years, and he was to bring her home at the end of that period. He failed to do so, and kept her abroad for two years more. Remittances became short and she returned to find that her husband had squandered her property, and she obtained a divorce. Resultant worry, according to the dermatologists consulted, turned her hair white. There was marked recession of the alveolar process and gums from interstitial gingivitis, as well as rapid tooth-decay.

The husband of a woman of 35 years suddenly died, plunging her into deep depression. Her teeth softened rapidly and decayed.

In all these cases abrasion or erosion, or both, and in some cases discoloration of tooth-substance, occurred. That teeth decay during illness all observers admit.

A surgeon of 64 years with arterio-sclerosis has an unusually well marked abrasion and erosion with interstitial gingivitis and loosening of the teeth.

A mechanical engineer of 48 years has rapid erosion, discoloration, interstitial gingivitis and loose molars.

Smale and Colyer (2) have observed erosion and abrasion with gout.

Tomes (3) mentions the case of an anæmic girl reduced to prostration by acute dyspepsia and confined to her bed for some time. She was so hysterical that it was difficult to correctly diagnose her condition. At one time there was great tenderness of the teeth and general periostitis in the front of the mouth, which, to judge by the color, seemed to have resulted in the death of the upper central incisors. The use of alkaline applications had no effect, but the patient's general condition improved and the disease made very little progress.

Marshall (4) relates the case of a man of 45 years in which the six anterior teeth and the right first bicuspid of the upper jaw were greatly affected, the enamel being completely removed from the anterior surfaces of all the teeth mentioned, with a considerable portion of the dentin, leaving an inclined plane pointing backward and extending from the margin of the gums to the ends of the teeth, shortening the anterior teeth to the extent of about the sixteenth of an inch.

The denuded surfaces were not all grooved in one direction; the central incisors and the left lateral were grooved horizontally like the others, but were also grooved longitudinally at the cutting edges.

Many cases of erosion, according to Darby (5), are associated with the gouty diathesis. This constitutional condition is, in his opinion, an important factor in causation.

Miller (6) mentions the case of a man of 45 years, who was in fair health with the exception of an occasional attack of asthma and a rheumatic tendency, and who was the subject of a well marked case of erosion.

My attention was called to erosion and abrasion three decades ago, while making investigations among neurotics and degenerates for other purposes. Degenerate children were found to have erosion and abrasion of the temporary as well as the permanent set of teeth. In paretic dementia—a disease which usually runs a rapid course and terminates in death—abrasion is almost always marked; sometimes erosion occurs. In locomotor ataxia erosion and abrasion are always present, frequently to a marked degree. In practice I find erosion and abrasion of the temporary teeth—especially of the incisors and canines that have remained in the mouth for a longer time than normal—after the roots have become absorbed and the pulps have been destroyed. Patients with hard, sound, normal teeth up to a certain period may afterward, from neurasthenia, degeneracy, or grief, show marked traces of erosion, abrasion and decay. The same is true of syphilis, tuberculosis, or any other constitutional diseases.

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(2) "Diseases and Injuries of the Teeth," p. 280

(3) Marshall's "Operative Dentistry," p. 363.

(4) Trans. Amer. Med. Association, 1884.

(5) Marshall's "Operative Dentistry," p. 366.

(6) *Dental Cosmos,* March, 1904, Vol. XLVI, p. 177.

Erosion and abrasion are often seen in the permanent teeth after the pulps have been destroyed.

Erosion, according to Miller, "is an effect observed in healthy teeth with living pulps, as well as on pulpless teeth, and on natural teeth worn as pivot teeth or on artificial bases."

Erosion and abrasion are observed upon the cutting edges of the anterior teeth, especially the central incisors where there is no friction from opposing teeth. Occasionally the central incisors, either upper or lower or both, alone are involved.

Erosion and abrasion are found in mouths with healthy gums and mucous membrane and upon teeth in localities where acid secretions could have no effect. The character and shape of the abraded surfaces indicate that the origin is from friction.

Change in color of the teeth is often very rapid after prolonged illness, such as pneumonia, typhoid fever, syphilis, tuberculosis, etc. I have noticed many cases of change in color after illness in persons who have had partial sets of teeth or when a crown had been inserted. All are familiar with the rapid change in color as patients advance in years. Teeth often change color during pregnancy.

I purposely grouped "Constitutional Causes of Tooth-Decay, Erosion, Abrasion and Discoloration" under one heading for the reason that I expect to show that the changes which take place in the pulp from constitutional disturbances modify tooth-vitality. The local causes are thereby accelerated. In all the cases enumerated, either the nervous system or blood supply or both are involved. While all of these lesions are observed early in life, they are most active after forty years of age. It is especially at the senile stage—the fifth period of stress, or period of involution, when the excretory organs, from overwork or nerve tire, cause faulty metabolism and auto-intoxication—that the teeth undergo changes indicated by rapid decay, discoloration, erosion and abrasion.

Changes taking place in tooth-structure must necessarily occur either in the blood stream or nerve tissue. Investigations of nerve lesions have demonstrated that in most diseases, nerve-end degeneration takes place, as Sidney Kuh (7) has shown. In some of the toxic forms, as, for instance, in neuritis due to poisoning with lead and arsenic, the cells of the spinal cord as well as those of the spinal ganglia and brain may be diseased and the toxic substances may attack these cells before the nerve fiber itself is altered. This hypothesis explains why pronounced degeneration of peripheral nerves occurs without causing any appreciable symptoms. Pitres and Vaillard first showed that after typhoid fever many nerve fibers are found degenerated in cases where, during life, symptoms of neuritis were absent. The same observer found like states in the nerves of those who had died from tuberculosis. Later observations have extended these conditions to such diseases as diphtheria, syphilis, alcoholism, carcinoma, inanition, marasmus, arterio-sclerosis, and leprosy; in the

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(7) *American Medicine,* Vol. III, No. 21, pp. 865, 868.

so-called rheumatic neuritis of the facial nerve, and in inflammation due to articular rheumatism, gout, puerperal infection, tuberculosis, etc.

The method of cell-poisoning has been observed in other intoxications (8). Certain groups of neurons are more susceptible than others to a given intoxication. The same group of nerve cells in two individuals may react very differently to similar doses of the poison. The syphilitic toxin shows a decided preference for certain parts of the cerebral cortex, other areas being less affected. The nerve endings in all parts of the body are markedly involved, especially those in and about the teeth. Peripheral nerve degeneration results where the blood current or the nerves themselves are involved from faulty metabolism, neurasthenia, etc.

If disease affects nerve endings elsewhere in the body, it is but reasonable to believe that nerve endings, bloodvessels and connective tissue in the pulp will likewise be involved, since the pulp is an end organ situated within bony walls, and a transitory structure is doubly susceptible to disease. The tooth pulp is at its highest physical development when it commences to form dentin. From that time it degenerates; it begins to lose its blood supply and its nerve energy As age advances, the blood and nerve supply is almost at a minimum. Is it surprising that so few pulps are found in normal condition?

For the past eight years Dr. Vida A. Latham and myself have made a special study of dental pulp pathology. The results of our efforts have been presented before the Section on Stomatology of the American Medical Association and published in both medical and dental journals. Teeth in all stages were obtained from patients suffering from many diseases. These teeth upon removal were placed in warm water, salt solution, and Müller's fluid. The pulps were removed and placed in Müller's fluid, Ehrlich's fluid, formalin, and in Weigert's chrome alum solution. Sections were cut by the freezing method and stained. The staining was done by the following methods: Weigert's osmic acid and hæmatoxylin, Mummery's iron and tannin, iron and hæmatoxylin, Freund's gold, Underwood's gold, and lemon juice and gold.

Weigert's stain for medullated nerves was used on tissues hardened in Müller's chrome alum, and good results were obtained with both Müller's and formalin-hardened tissues, the medullated sheath of the nerves taking the stain.

The osmic acid method was used similarly to the above, and gave good results following Weigert's chrome alum solution.

Mummery's iron and tannin, used after Müller's fluid, stained the nerve fibers, but the results were not so good as with the two previous stains. Mr. Howard Mummery, however, has been able by this stain to trace fine nerve fibers from the nerve bundles.

Iron and hæmatoxylin gave good results, the fibers in some places being traced to the apex of the pulp.

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(8) Barker, "The Nervous System," p. 243.

Of the different gold methods, Freund's has given us the best results, although some of the results of staining tissues hardened by all the methods have been good.

In a general way, pathologic conditions of the pulp were demonstrated—vascular changes and circulatory disturbances, thrombosis being very common, as also embolism, because of the vast number of loops and want of expansion; endarteritis obliterans, and arteriosclerosis. These diseases are based, in a measure, upon pulp-embryogeny, anatomy, environment and the end-organ nature of the pulp, as already stated.

Some years ago (9) I demonstrated the nerve endings in the coats of the bloodvessels of the pulp, showing its vasomotor system. The sympathetic system in disease, therefore, must play quite a part for good or evil in nerve endings and bloodvessels of the pulp. In a later paper (10) I demonstrated Wallerian degeneration and nerve sclerosis, showing that changes in nerve endings and nerve tissue involve the pulp.

As a result of disease of the bloodvessels and nerves of the pulp with external influence, there are retrogressive changes of inflammation: abscess, cloudy swelling, fatty degeneration, mucoid, colloid, hyaline, amyloid degeneration, pulpstones, spherites, neoplasms, fibroma, etc. Some of these conditions have been discussed by Wedl, Tomes, Smale and Colyer, Hopewell-Smith, Black, Bödecker, Arkövy, Andrews, Römer, Morgenstein, Caush, Latham, and many others, whose details can be studied at length in the original monograph.

It now remains to demonstrate what relation the pulp bears to tooth-structure and tooth-resistance. I can not do better than quote at length from a paper entitled "The Vital Action of the Dental Pulp" (11), by the well known scientist, Dr. R. R. Andrews:

"When the tooth is fully formed, the principal function of the pulp is for vitalization of the substance of the dentin, by means of its fibrils, which permeate into every portion of the matrix of the dentin. Its function is not only to vitalize, but it may again assume its formative function whenever causes for repair demand this. . . . We can not look on its tissue in life, . . . conclusions must be drawn from what is shown to have taken place when the tissue was alive; the living pulp, with its bloodvessels and nerves, nourishes the dentin; vital changes do take place, and the pulp is the source of vital action. it is a living organ, subject to any physiologic or pathologic process which may act on any living matter; its connection with the general economy must be similar to that of other tissues. It will respond to the action of returning health, and caries which has commenced has been arrested by this vital action, appearing as polished blotches on the teeth, which are not uncommon. Professor Miller, in his work on Micro-Organisms of the Human Mouth, calls this condition a spon-

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(9) *Journ. Amer. Med. Association,* December 19, 1903.

(10) *Dental Digest,* December, 1903.

(11) Read before the American Medical Association, Section on Stomatology, at Atlantic City, June 7, 1904.

taneous healing of dental decay. The dentin, which had become softened, has become hard again, and the decaying process is stopped. This change also takes place in the temporary teeth. The healed dentin retains its discolored appearance, but becomes nearly as dense as normal dentin. These changes have been brought about by vital action, and this action came from the agency of the pulp.

"When the dentin is irritated by infection or its surface is uncovered by a break, there immediately follows a period of vital activity. If sections of a tooth made when these changes are taking place be examined, the formative cells in that portion of the pulp nearest the point of repair are found filling up with glistening globular bodies and the tissue about it is showing an increased vascularity, as though active formative action were taking place."

Andrews was satisfied that these appearances were the result of the vital action of the pulp in its efforts to repair the tissue and that the minute glistening particles within the canals were in many ways similar to the minute globular bodies found in the tissues while the dentin matrix was developing.

"The protecting consolidation is found in teeth that are worn down, usually in the mouths of old people, and when this change has taken place these teeth are not liable to decay again, except under very favorable circumstances. . . These changes are due in a large measure to normal conditions as regards the vitality of the individual; but in cases where the constitutional condition is below the normal, even where conditions seem favorable to decay, there is always an attempt made to retard the infection. Under certain conditions of environment and infection, penetrating decay is so rapid that the vital action of the pulp is overwhelmed, and the pulp becomes exposed and is in a pathologic condition even before the breaking away of the cavity walls.

"The pulp is the central and largest source of vitality to the tooth, and it acts through its myriads of fibrils. . . . Pain of the dentin following the touch of an instrument or from any irritation is expressed through the agency of these fibrils, and we become conscious of the sensation through them. . . . The dentin is and was meant at all times to be a living tissue. It receives impressions of injuries and responds by processes of repair. Some of the ablest men in the profession have questioned the further value of the tooth-pulp after the full formation of the tooth has taken place. They look on it simply as a formative organ and consider its mission closed with the formation of the tooth. It is, therefore, in their judgment quite as well to destroy it, take it out, and fill its chamber. The microscopic appearance of dentin after the pulp is removed shows that a large amount of dead organic tissue is left within the canals that can not be taken out, and the dead tissue is a source of considerable danger to the health and vitality of the pericementum. . . . With death of pulp, not only is sensation in the dentin lost, but also all the changes which vitality gives to an organ, such as nutrition and recuperation. These can

never by any possible means be revived. . . . In cases of a lessened vitality we may expect more or less pericementum trouble, a darkening of the tooth, a recession of the gums, and an absorbing of the alveolar processes. The tooth is beyond the influence of any systemic process, and there is no probability of a change for the better."

Many of the facts here depicted by Dr. Andrews have been observed by most practitioners. The vividness of the portrayal of the vitality of the pulp must be appreciated by all. If, under certain conditions, the pulp can take on recuperative power at any period of life, retrogressive changes must also occur under certain conditions.

In summing up, it is clear that owing to the evolution of the face, jaws and teeth, the teeth are naturally prone to degeneration (decay, erosion, abrasion and discoloration). While the law of the survival of the fittest, so far as general health obtains, evolution and degeneration of the teeth are progressing, slowly but surely. The influence of taint and disease are carried with the teeth from generation to generation. The chances for recuperation of tooth-structure by the inheritance of better blood-making are not so great as in the case of other structures of the body. The tooth has always been a very variable factor in evolution.

In somatic diseases, in metal and drug poisoning, in pregnancy, as well as in pulp-disease itself, vital action of the pulp is involved. Vital changes take place, the fibrils become diseased, tooth-resistance is lost, discoloration and softening of tooth-structure occur. Friction wears away the teeth, and, owing to want of tooth-structure, lactic acid ferment causes rapid tooth-decay.

DEVELOPMENTAL PATHOLOGY AND TOOTH DECAY.

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D., CHICAGO.

There is a fascination about theories which exploit a single etiologic factor that carries away a large class of minds unaccustomed to analytic thinking and indisposed to intellectual exertion. For the same reason such theories are apt to be received with extreme skepticism by minds accustomed to analyzing the results of research. This last mental attitude is apparent among scientists of the dental profession in regard to the lactic acid theory of tooth decay, so eloquently presented by Miller of Berlin. The solution of the problem was too disappointingly simple. It bore ominous resemblance to many exploded one-sided solutions of etiology which have won the admiration of minds slovenly neglectful of analysis since inductive philosophy began to dominate. Like these exploded etiologic theories, the lactic acid theory had an attractive aspect and a superficial semblance of facts in its favor. Furthermore, it played to the sociologic reformer whose God is parsimony, by furnishing materials for an onslaught on candy. The skepticism which the theory produced was strongly in evidence in the remarks of Black and Truman, in the discussion of Miller's paper at the Fourth International Dental Congress.

The rule governing the adoption of any working hypothesis is the simple absolute one that it must not only explain all the facts, but must exclude all other explanations. Unless this be the case the hypothesis suggests no remedy capable of dealing with the results alleged to follow the conditions. Given an allegedly simple cause which does not set in action secondary causes, or does not require predisposing factors for its operation, inevitably removal of such cause must be followed by the cessation of its effects. This is particularly true where prophylaxis is so simple as in the case of the lactic acid theory. It is at least a quarter of a century since this theory was announced, yet tooth decay continues its ravages and is much more in evidence than ever. The lactic

acid theory in this respect closely resembles the germ theory as revived by Pasteur. At the outset of the revival the germ was alleged to cause everything, but soon it was found that culture mediums were necessary for its operation, and furthermore, that the chief effects were due to toxins produced by the germ. The whole problem then resolved itself into the etiologic moment of the old clinicians. This etiologic moment consisted of the immediate determining factor serving like a spark to a powder magazine, and the powder magazine consisting of the condition of the patient when born as affected by the development through which he passed, and finally by the condition in which he was at the time the spark was applied. Upon these last would turn his guards against disease given by the state of his leucocytes and his antitoxin forming organs. What is true of the germ theory was true and is true of any theory by which a single etiologic factor is alleged.

The viewpoint of this lactic acid theory at the outset is defective. It is true that children in civilization eat candy and their teeth decay rapidly, but it is equally true that the negro in the sugar plantation uses prodigious amounts of sugar cane and sugar products, yet retains his teeth to old age. At the outset, therefore, the facts do not fit the theory, but indicate, granting everything that is claimed for lactic acid as an exciting cause, that there exist more potent causes of a predisposing character.

The claim so often made, that a given subject remains despite all seeming hygienic neglect with perfect teeth to an extreme old age, may be granted, yet such an admission proves nothing, since it is notorious that one scion of a defective family gains physical health by the sacrifice of all the higher qualities of the race during the struggle for existence between organs, waged with most intensity before adolescence is completed. The defective family generally contains a large number of scions dying at the various periods of stress in youth. A single selfish animal parasite is long lived whose health is the result of his loss of higher attributes. The negro, like the ape, notoriously sacrifices the powers of higher development at the period of puberty to the necessities of food-getting and reproduction. What is true of the negro and ape is true of all other races between the two extremes. The physical aspect of this is shown in the sacrifice of the dermal bones that eke

out the deficiencies of the skull and face formed from the chondrocranium. Proper development of the jaws turns on the proper amount of dermal bone. If this be not furnished the jaws, the brain and skull may profit, but the teeth and jaws will lose. Proper development of the brain depends on development of the brain itself, not only in its powers as regards sensation and motion, but also in its powers of regulating growth and blood supply. If these last powers be interfered with irregularities of dermal bone development result. Not only that, but proper innervation of the teeth and the bone will fail. The sacrifice of the higher gains of the race to jaw, teeth and reproduction occurs early in the ape, whence the human aspect of the young gorilla as contrasted with the jowl and bestial face of the adult. In the negro the same occurs at puberty, but to a lesser extent. In higher races the same pubertal struggle for existence between jaws, face and reproduction on the one hand and the higher qualities on the other is observable.

The deciduous teeth are, remarks Stanley Hall (Adolescence, Vol. I, p. 77), more primitive in type and the molars are useful in warfare, but suggest a change of food habits and involve greater length of jaw to make room for them and greater strength of muscle. Hence pubertal increase of the lower jaw may be assumed. Increased prominence of the chin, breadth of the lower jaw, propensity to chew, to bite hard things, or to perform feats of strength with the teeth and jaws, the frequency with which clenching the teeth is mentioned in statistics as to anger, which shows a great pubertal development of irritability, teach how clearly jaw tensions, once a chief factor in battles, are still associated with pugnacity. One marked jaw development of this pugnacity was the simian diastema for reception of the cuspids as used for fighting purposes. The space so used was gained at the expense of the teeth, and this diastema loss of jaws and space persisted in man long after the use of the jaw for fighting had disappeared.

This constitutional factor of the periods of stress involved by the struggle for existence between organs, functions and structures, pointed out by Roux (Der Kamp der Theil im Organismus, 1881) nearly a quarter of a century ago as a necessary corollary of the law of economy of growth (Goethe, Aristotle, From the Greeks to Darwin), ruling use and disuse as a factor of development, plays

the chief part in developmental pathology, as DeMoor (Evolution by Atrophy) has lately shown, and as was pointed out by A. H. Thompson (Dental Cosmos, Vol. 19, p. 237). Degeneracy or "suppressive evolution," as Thompson called it, is a part of developmental pathology which exerts beneficial or malign influences according as it attacks lower structures for the benefit of higher or sacrifices the higher to the lower. Degeneracy may convert the third eye into a pineal body or may sacrifice the paired eyes to the third eye by creating a cyclops. It may sacrifice brain potentialities to the jaws and jowl, as in the ape, or vice versa, as in higher man. It actually sacrifices liver, kidneys, adrenals, brain and eliminative powers to length of extremities. These factors, so well demonstrated and employed in medicine, are too much neglected in dental pathology, which deals with structures so transitory as to readily fall under their influence. The constitutional factor converting teeth from the megadont to mesodont and even to microdont types excellently illustrates this.

In lieu of the broad consideration necessitated by the results of modern developmental pathology, dental hypotheses are generally "simple" half truths. Lactic acid in the system implies, for example, local imperfect oxidation and elimination. Behind it must therefore lie arrests of development of eliminating and oxidizing organs. The same illogical tendency is apparent in other hypotheses.

While some admit there is a diathesis, they do not believe that tooth structure can be changed by health and disease through the pulp. Some believe there is a difference in the "amount of lime carbonate and phosphate," thus causing a difference in "those salts that are more easily dissolved and those that are dissolved with more difficulty." Others argue that the teeth are degenerating, hence the body or race must degenerate as a whole. As statistics demonstrate that the longevity is increasing from year to year, this cannot be true.

Another class thinks that direct heredity has something to do with tooth decay, but is startled by finding that the parents of a child who has poor teeth have excellent teeth. Others argue that the aborigines lived upon coarse and simple food, while at the present day foods are prepared and of greater variety. This theory ignores the necessary changes of environment, and the

fact that the Scotch have lived for centuries upon oatmeal gruel, and the Chinese, Japanese, Malays and Polynesians live upon prepared rice, and yet have a high quality of tooth structure.

Another says, "We should select our food more carefully, with a view as to its value as a tooth builder rather than the pleasure it gives the palate." He is, however, unable to suggest any method or food that will meet this indication. According to another, "Indigestion is far more often produced by defective teeth, which prevent proper mastication," yet the Scotch, the Chinese, the Japanese, the present method of bringing up children, caring for the sick, etc., show that the teeth are not necessarily required for mastication. These do not have indigestion despite the fact that they live upon soft food.

According to another, caries is localized in places where there is no friction and where the enamel is thick, but decay often takes place upon the cusps of all the teeth, where the enamel is the thickest, and upon the buccal and lingual surfaces, where friction is always present.

Decay of the teeth is more common among defectives in state and private institutions than among normal people. If further evidence in regard to tooth decay and tooth degeneration be desired, compare the teeth of the upper and lower jaw. Arrest of development of the upper jaw is more common than of the lower, owing on the one hand to the upper's fixed attachment to the other bones of the skull under the law of economy of growth, and on the other hand to the mobility of the lower. Hitchcock, Magitot and others have found decay of the teeth more frequent in the upper than in the lower jaw. The checking influences of the nervous system which produce arrest of development of a jaw bone must affect the embryonic structure of the teeth, hence the more frequent decay in the upper than the lower jaw. Decay of the teeth is more common in arrested jaws where the teeth are irregular than in well-formed jaws and teeth. The lower jaw being movable, more blood is sent to the part and the bone is less liable to become arrested. The same fact explains why there is less decay of the teeth in the lower jaw, as the vitality of the structure is greater.

Some English dentists have lately attributed the rapid decay of the teeth to the modern methods of manufacturing flour at the

Minneapolis mills, ignoring the fact that teeth decayed nearly or quite as rapidly when the wheat was ground by the old fashioned and slower process. Each of these suggestions has some value, but they are not far-reaching enough to account for all conditions.

More than two decades ago I laid stress upon the fact that tooth degeneration or decay was a natural process which came under the law of economy of growth, which is the law underlying developmental pathology. No organs of the body illustrate the law of use and disuse of structures so well as the teeth. Once they were all-important for the life of the animal, but now man may live three decades beyond three score and ten without them.

The cone-shaped tooth found in the reptilian type and in toothed birds is the primitive tooth (Osborn). These were in the first place organs of the skin which developed over the surface of the body. They were well nourished through the pulp. The teeth of the shark first departed from the primitive type, since they did not develop upon the surface but deep down in the tissues. These changes in tooth evolution were for the benefit of the animal. This method of tooth formation, converting epithelial cells without vascular supply into enamel rods, is a ready degeneration of the cells for the body's benefit.

Degeneration or its ultimate decay, as I have called it in my lectures and papers, progresses with change in the shape of the tooth from the cone. Two theories are advanced as to the method of evolution from the cone tooth to the bicuspid and molar—the concrescence theory by Magitot and the differentiation theory by Osborn. So far as this article is concerned, it makes no difference whether the primitive cone teeth group themselves in twos or fours to form bicuspids and molars, or the single cone tooth gives off shoots or buds to form cusps and roots. As the vertebrates develop into higher organisms mixed sets of teeth are necessary for the habits and convenience of the animal. These are divided into incisors, cuspids, bicuspids and molars.

Under the law of economy of growth, the face and jaws and teeth change according to the environment of the animal. Living in the open air upon primitive coarse foods obtained and prepared by the mouth, large jaws and good sound teeth prevailed. The function of the alimentary canal was performed suitably with the environment. Extreme as was the change from the holding

cone-shaped tooth to that of the masticating bicuspid and molar, the bell-shaped crown, with thick, well formed enamel for grinding and crushing, was conducive to health.

Tooth decay necessarily goes hand in hand with rise in evolution. This evolution is a race for supremacy between the man of brawn and the man of brain. The teeth of the anthropoid apes are large at their sockets and the crowns taper to sharp cusps; the cuspids are prominent, taking the type of the carnivora. In the lower races a slight change occurs, the roots of the teeth are closer together, the necks smaller, the crowns broader. In the higher races the roots are still closer together, the alveolar processes longer and thinner, the necks of the teeth smaller, the crowns smaller and less bell-crowned, and their sides straighter.

Between these two descriptions the teeth of man have reached the highest physical development in evolution both as to quality and number. The perpendicular line between the brain development and facial atrophy in face evolution has now been crossed, and pathologic conditions of the teeth and jaws necessarily begin. The brain has developed at the expense of the jaws and teeth under the law of economy of growth. Man reached his highest physical development when he had thirty-two well formed teeth. The continued recession of the jaws no longer permitted thirty-two teeth, and they are now being dropped, commencing at either end of the jaw. The third molar and lateral incisor are growing smaller. The shark, certain reptiles, toothed birds, many marsupials, and some mammals have as many as seventy-two teeth. Advance along the line of higher types is made by dropping teeth in front and behind.

While these changes are progressing tooth structure is degenerating in density, thickness and quality. Pits, furrows and grooves in the enamel and interglobular spaces in the dentin are the rule. People with unstable nervous systems suffer to the most marked degree. Other evidences of jaw and tooth degeneration in muscles and their attachment have been observed. Retraction of the upper lip in anger, uncovering the cuspids, is an atavism, since it is present in all carnivora preceding combat, whence its marked condition at puberty. Harrison Allen pointed out that the alveolar borders tended to parallelism in savages, while in civilized races the height of the anterior alveolar border

was greater than in the vicinity of the molars, from degeneration of the platysma myoides muscle. Jaw muscles and their attachments are much smaller in modern than in early races, and Ward found the lower jaw much lighter in civilized races.

The struggle for existence between the jaws and teeth is not always harmonious. Arrests of jaw take place, owing to an unbalanced nervous system, and the teeth do not become arrested in proportion, although their shapes change from broad large crowns to narrow cone-shaped crowns. This is tooth degeneration. In most cases diminution in size of the dental arch does not keep pace with the arrested jaws and irregularities of the teeth result, or the third molars become impacted between the second molar and ramus. Pits and fissures are now observed in the enamel and interglobular spaces in the dentin.

The skulls of ancient Egyptians, Greeks, Roman soldiers, Etruscans, Phœnicians, ancient Lake Dwellers of Switzerland, Firbolg, and prehistoric skulls from the Ireland bogs, Peruvians, ancient Hawaiians, Cliff Dwellers and Mound Builders, all show incipient decay. When decay is found it is in the sulci of the crowns, and very rarely if ever at any other point. If such a condition should occur, the starting point would be in the sulci where the enamel is defective. In most cases only a dark line is observed in these fissures. The enamel is so perfect, thick and dense that decay is almost impossible. The only faulty developed tooth structure is located at the weakest part of the enamel, the sulci. The same conditions are observed when decay is found in the teeth of animals, as the fissures are the first to be diseased. In modern races, owing to faulty development, decay may occur at any point, not excepting the cusps, as well as in the fissures of the teeth. The more advanced the race is in civilization, the greater is the mental development, with the greater local degenerations.

A class of cases which have come under observation are as follows—Children of strong, healthy constitution may erupt all their permanent teeth, anterior and including the first permanent molars, with fairly good enamel and with little or no decay. At seven, eight or ten years of age, after one or more of the eruptive fevers, the second permanent molars erupting have faulty enamel in the sulci and at the buccal pits. Decay may take place within a year, and the cavities starting in the sulci and in the buccal pits

may be so large as to meet. The enamel and dentin are very soft in these teeth, showing conclusively that the constitutional diseases affected the enamel and dentin through the blood streams and nerve endings before the teeth erupted. The modern etiquette (munching the food with the lips closed and without mastication, and cutting the food with the fork instead of the knife) is bringing about a greater change in evolution under the law of economy of growth or use and disuse of structures than any other one thing. The teeth of this class under the microsope show fissures and defects throughout the enamel. (I have examined the enamel of teeth under the microscope sufficiently to warrant my conclusions, and have only to refer you to the beautiful specimens of defective enamel illustrating the paper of Miller read at the Fourth International Dental Congress, and "Is There Uncalcified Tissue in the Enamel?" by Douglass E. Caush, published in the February, 1905, *Dental Cosmos.*) Here then are the great underlying causes of tooth decay, namely, "want of tooth resistance" from within, disuse, and tooth degeneration along the line of evolution and disease. (Talbot: Constitutional Causes of Tooth Decay, DENTAL DIGEST.)

RESUMÉ.

1. Few dentists have had proper analytic training.

2. A broader education is necessary to practice stomatology successfully in the future.

3. Pathology of the head, face, jaws and teeth must be studied along broader lines.

4. In the evolution of man the face, jaws and teeth are sacrificed for the benefit of the brain.

5. Degeneracy or suppressive evolution, as Thompson calls it, is a part of developmental pathology, which exerts beneficial or malign influence according as it attacks lower structure for the benefit of higher or sacrifices the higher to the lower.

6. It may sacrifice brain potentialities to the jaws and jowl, as in the ape, or vice versa, as in higher man.

7. The teeth decay more rapidly in pregnancy and constitutional diseases, especially in those cases where the nervous system is involved.

8. The teeth of primitive races decay, but the starting point is

always where the enamel is defective.

9. Decay of the teeth is commoner in arrested jaws than in those well developed.

10. Decay is more common in the teeth in the upper jaw than in the lower.

11. Jaw and tooth degeneration under the law of economy of growth; whereby a structure is lost for the benefit of the organism as a whole, is the greatest determining cause of tooth decay. Without it lactic acid ferment would act rarely if at all.

12. Lactic acid ferment is an exciting cause of tooth decay in man's evolution.

13. Tooth decay naturally occurs hand in hand with rise in evolution.

14. Rise in evolution means increased control by the central nervous system of local nerves, whether of growth, sensation or motion, so that explosive performances do not occur as in lower types. Resultant disuse by the local nerves of function results in lessened nutrition. The jaws and teeth being variable structures are most affected .by control of local trophic, sensory or motor nerves, since it is in unstable variable structures that explosive excess is most apt to occur.

ADVANCE AND RETROGRESSIVE EVOLUTION.

BY EUGENE S. TALBOT, M.S., D.D.S., M.D., LL.D., CHICAGO.

Every living being is exposed to forces which act on its organism so as to produce three results—to keep it in statu quo; to increase the complexity of its structure, or to diminish the complexity of its structure. Every living being has before it three possibilities: statu quo, elaboration or advance evolution, and degeneration or retrogressive evolution. Underlying these are various phases of environment which depend upon the supply of nutriment to be assimilated and the power of assimilation. Degeneracy or retrogressive evolution may be defined as a gradual change of structure whereby the cell structure of the organ or organism becomes adapted to less varied and complex conditions of life. Elaboration or advance evolution is a change of structure whereby the cell structure of the organ or organism becomes adapted to more and more varied and complex conditions of existence. In degeneracy there is suppression of form corresponding to cessation of work. The organism is in a system of balance whereby the benefit of the whole is secured. The amount of nutriment and assimilation being fixed, a struggle for existence occurs between different cells, structures and organs. Under physiologic balance, specialization restricting function lessens the nutriment needed for a given organ or cell. Through this specialization cells surrender their reproductive powers for the benefit of the organism as a whole. Specialization is an expression of advance, while generalization is an expression of degeneracy, which hence becomes necessary in a part for the benefit of the body as a whole.

The organism as subjected to environment is the product of four factors—direct heredity from the immediate ancestors; immediate and remote atavism. Remote atavism usually favors degeneracy of the organism as a whole. Immediate atavism and type heredity therefore often combine against direct heredity and remote atav-

ism. Direct heredity tending to retrogressive evolution occurs through general weakness, manifested along the lines of least resistance. Neurasthenia of certain organs in the parents often causes organ instability in the offspring, whereby lower structures and functions gain at the expense of the higher. The contest for existence along the structures as manifested by the various organs, even when for the benefit of the organism as a whole, has varied greatly during the course of zoologic development.

The face's contest for existence with the brain has frequently

FIG. 1.

caused cranium and jaws to assume for defense and food purposes a lower type. The face (a characteristic of the higher vertebrates) acquires increased importance with rise in the zoologic scale. The position of the face in embryonic development was originally determined by the head bend. If a median longitudinal section of the head occupies a triangular area divided into quarters the lower posterior quarter corresponds to the mouth region and the other three-quarters to the brain. As development progresses the mouth quarter enlarges so disproportionately in relation to the rest of the head as to project forward in front of the forebrain. In this stage, which is represented by adult amphibians, the facial apparatus is very large proportionately to the cranium. In reptiles the mouth region is elongated still further in front of the brain case, resulting in the long snout. In mammals a third stage is established by the great increase in size of the forebrain, and in

consequence the brain extends over the snout. In man, whose brain has the maximum enlargement, the facial apparatus is almost entirely covered by the brain. During zoologic evolution the face, while serviceable to the animal for certain reasons of general constitutional character (food-getting, means of defense,

FIG. 2.

and obtaining mates), is less so than brain growth. A struggle for existence therefore inevitably results between the tendency of the face to appropriate power of growth and the like tendency of the brain, which in defective organisms produces marked degeneracy of the one for the benefit of the other. This struggle is further complicated by the embryonic relations to both of the hypophysis, since this body admittedly exerts an influence over bony growth, most markedly (but abnormally) exhibited in acromegaly (excessive bone growth). In this contest for existence degeneracy necessarily takes the direction of least resistance. The brain is the last acquirement in vertebrates, considered from the standpoint of necessity, while the face (also a late

acquirement) is much less complex. The latter will therefore present degeneration in shape while the former exhibits it in shape and function. Furthermore, during the embryonic period brain development of necessity is more immediately affected by degeneracy than the face, which gains in evolution at its expense. Degeneracy stigmata most likely to attract attention are hence in

FIG. 3.

the order given—those of the face, jaws and teeth, ears, eyes, cranium, body, bodily functions, brain and spinal cord. With increased power of securing and assimilating food disuse of the teeth and jaws results, as fewer and smaller teeth are needed and less jaw. If the jaw yields most, less room for the teeth is present and irregularities of one type result. The reverse conditions exert similar influences.

Conditions which modify healthy development are, as I have elsewhere shown, ordinary and consanguineous marriages, intermixture of races, climate, soil, food, etc. These, however, do not produce such marked arrests and excessive development as are

caused by an unstable nervous system in the parent as well as in the child. The unstable nervous system of the parent, which produces arrests in the child, is often due to excesses in toxic

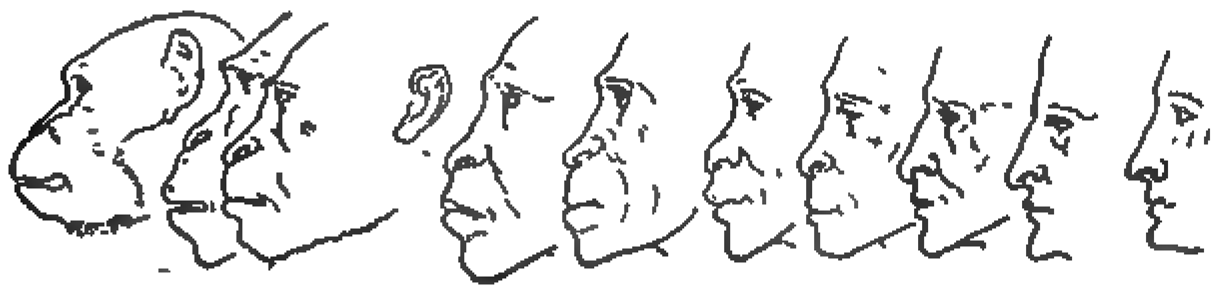

FIG. 4.

agents. These are divisible into those belonging to the condiments, medicines, foods and beverages; those arising from occupation, and the autotoxemias. Tobacco, alcohol, opium, tea, coffee, cocain, as well as lead, mercury and brass, produce toxic effects. Excesses in a social way, late hours, etc., may produce profound systemic nervous exhaustion with autotoxemia in the ancestor and especially the ancestress, likely to be transmitted as degeneracy to the descendant. The acute and chronic contagions

b

FIG. 5.

and infections of the parent, especially the mother, exert the same toxic influences upon the fetus, impoverishing it and checking healthy nutrition.

The factors producing degeneration in the child often arise from nervous exhaustion in the first generation, which implies a practical degeneration in function, since tone is lost. Every nerve cell has two functions, one connected with sensation and the other with growth. If the cell be tired by excessive work along the line of sensation or motion the function as regards growth becomes later impaired, and it not only ceases to continue in strength,

but becomes self-poisoned. Each of the organs (heart, liver, kidneys, etc.) has its own system of nerves (the sympathetic ganglia),

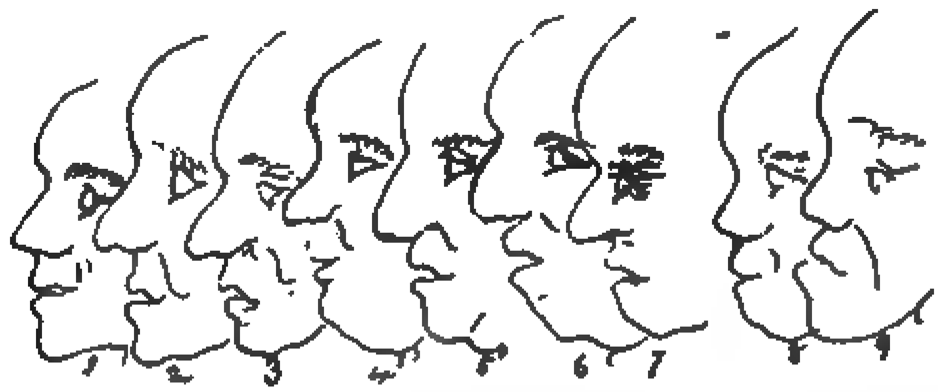

Fig. 6.

which while under control by the spinal cord and brain act independently. If these nerves become tired the organ fails to perform its function, the general system becomes both poisoned and ill-fed, and nervous exhaustion results. In most cases, however, the brain and spinal cord are first exhausted. The nerves of the

Fig. 7.

organs are thus allowed too free play and exhaust themselves later. This systemic exhaustion has local expression in the testicles in the male, in the womb and ovaries in the female. Because of it the body is imperfectly supplied with natural tonics (antitoxins) formed by the structures, and the general nervous exhaustion becomes still more complete. All the organs of the body are weakened in their function. Practically the neurasthenic, as regards his organs, has taken on a degenerative function, albeit

not degenerating in structure, since the restlessness of the organs is a return to the undue expenditure of force, which occurs in the lower animals in proportion as it is unchecked by a central nervous system. Through the influence of various exhausting agencies the spinal cord and brain lose the gains of evolution, and the neurasthenic is no longer adjusted to environment. Since the reproductive organs suffer particularly, children born after the acquirement of nervous exhaustion, more or less checked in development as the influence of atavism is healthy or not, repeat

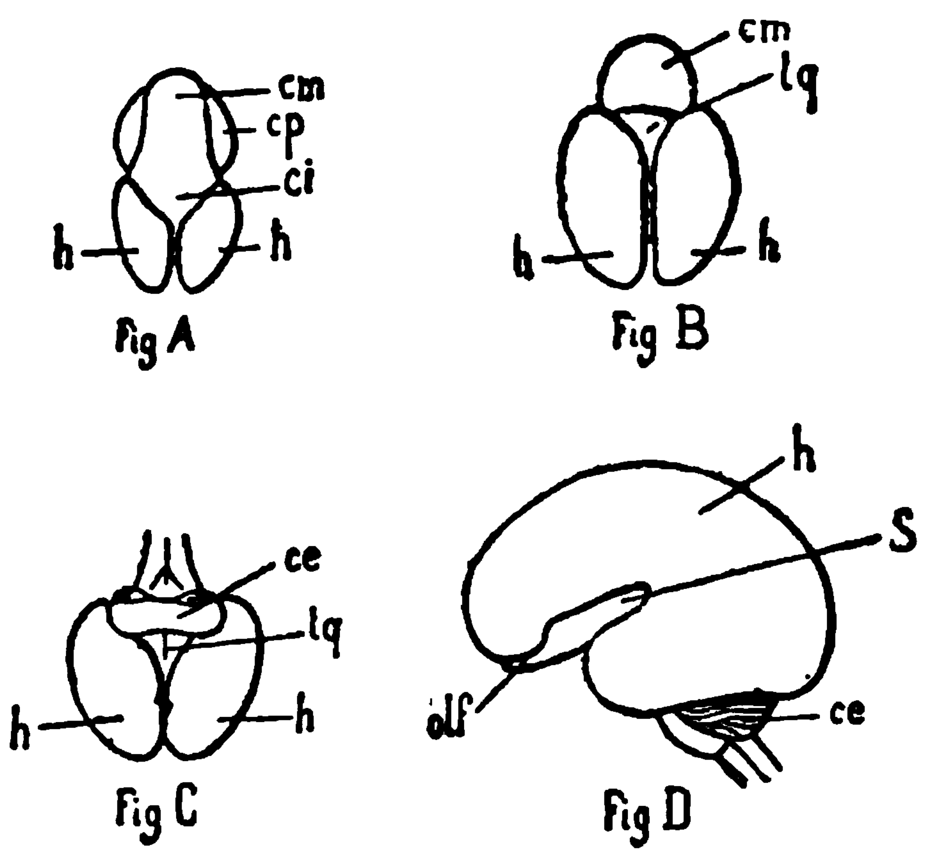

FIG. 8.

A, Brain of a human embryo of seven weeks; *h*, cerebral hemispheres; *ci*, intermediate brain or thalamencephalon; *c·n*, mid-brain; *cp*, hind-brain. *B*, brain of a human embryo about the beginning of the third month: *h*, cerebral hemispheres; *tq*, region of the corpora quadrigemina; *cm*, mid-brain. *C*, Brain of a human embryo at the middle of the third month; *h*, cerebral hemispheres; *tq*, corpora quadrigemina; *ce*, cerebellum. *D*, Human brain of the fifth embryonic month; *h*, cerebral hemispheres; *olf*, olfactory lobes; *S*, fissure of Sylvius; *ce*, cerebellum. (After Minalkovics, *Entwickelungsgeschichte des Gehirns*. Leipzig, 1877.)

degenerations in the structure of their organs, which in the parent were represented by neurasthenic disorders of function. As the ovaries of neurasthenic women are markedly affected by nervous exhaustion, the offspring of these do not retain enough vigor to pass through the normal process of development.

Maternal environment exercises an enormous influence on embryonic development in the direction of retrogressive evolution. Maternal shock produces arrests of development which are not photographic conditions, but survivals of embryonic states. While maternal impressions do have an effect, it is simply in conditions of arrest and not in photographic reproductions of the alleged

cause of the impression. In intrauterine life periods of stress occur around which, as Kiernan remarks, the disappearing and

Fig. 9.

developing tendency of organs necessarily centers. At these periods certain functions and structures are to be lost by the disappearing and others gained by the developing organs; maternal shock checks proper progress at these periods.

When systemic balance, the result of evolution, is disturbed by

Fig. 10.

change in environment the organs, as has been shown experimentally by Jacques Loeb (Untersuch zur Physiol. Morphologie), do not pursue their usual growth. Such disturbances are peculiarly apt to occur during periods of stress because of the then varying relations of different organs. Struggles for existence on the part of the different organs and systems of the body are hence

most ardent during the periods of intra and extrauterine evolution and involution. During the first dentition, during the second dentition (often as late as the thirteenth year), during puberty and adolescence (fourteen to twenty-five), during the climacteric (forty to sixty), when uterine involution occurs in woman and prostatic involution in man, and finally during senility (sixty and upward), mental and physical defects may, as I have elsewhere shown (Degeneracy, Its Signs, Causes and Results), be evinced in

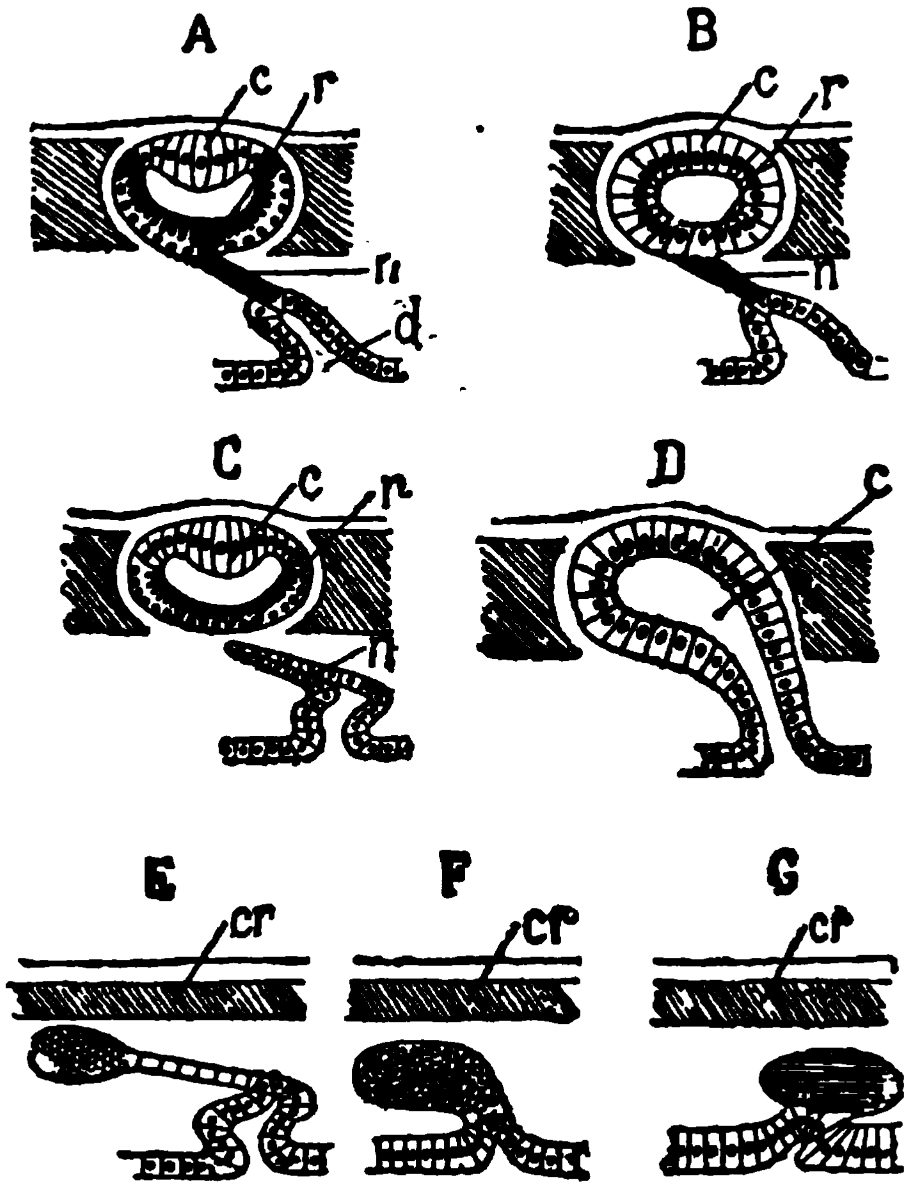

Fig. 11.

Diagram indicating the progressive evolution and the degeneration of the pineal eye.

A. Perfect pineal eye, as found in the slow-worm before birth, or in the adult Sphenodon (Hatteria); *c*, lens; *r*, retina; *n*, optic nerve; diverticulum of the thalamencephalon. B. Pineal eye in first stage of degeneration as it exists in *Chamaeleo* and as it was in the slow-worm before stage A. The lens (*c*), and the retina (*r*), are not differentiated. C. Pineal eye in the degenerate form found in *Calotes* and *Leiodera; c*, lens; *r*, retina; *n*, optic nerve in fatty degeneratoin. D. Very degenerate pineal eye as in *Cyclodus* and like the earliest stage in the slow-worm; there is no differentiation of the diverticulum from the thalamencephalon. E, F, G. Other modes of degeneration of the pineal eye. The eye lies within the skull and there is no parietal foramen; *cr*, cranial membranes; E, *Ceratophora*. F, birds; G, mammals. (After Baldwin Spencer.)

a congenital tendency which has remained latent until the period of stress.

The first period of stress is the most important so far as the head, face, jaws and teeth are concerned. It is called the senile

or simian period and occurs at four and one-half months of fetal life. The influence of neurasthenia in the parent may result in a bony arrest of development, shown to occur in animals by Charrin and Gley and in man by Coolidge. The facial bones, jaws and teeth are peculiarly liable to be thus affected. Though the effect of disease on the parent be but temporary, the child's development may be checked as to higher tendencies.

The factors entering into the struggle for existence most markedly involve the relations of the brain to the head and face. During intrauterine life the face loses and the brain gains. During the

Fig. 12.

first extrauterine period of stress, between birth and three months, the brain is one-fifth the weight of the body, while in the adult it is but one-thirty-third. During the first six months the brain doubles in weight. The effect of stress during this period would, under the law of economy of growth, be felt either in diminution of the quality or quantity of the brain, or in the preservation of these at the expense of more transitory structures like the face, nose, jaws and teeth. This is well illustrated in the contrasted skulls (Figure 1). After birth the face gains at the expense of the brain, and the body and face as a whole so gain on the growth of the brain that, as Havelock Ellis remarks, further growth from the third year onward, though an absolutely necessary adaptation to environment, is to some extent growth in degeneration and

senility. The loss of child potentialities is well shown in Figure 2 (after Ellis), where the perfectly developed being fulfilling the promise of the child is contrasted with the man that the child actually becomes.

Fig. 13.

At the periods of sex-differentiation, and the simian or senile period (Figure 3), irregular balance given the struggle for existence leads to imperfect sex-differentiation or premature senility. This last often produces irregular and incomplete ossification.

Fig. 14.

Since, as Harriet Alexander has shown, degeneracy is a process of evolution leading to alteration of form because of cessation of inhibition in certain directions resultant on diminished work, it logically follows that since diminished function precedes change of structure, increased function checks the change of structure in its biochemic stage. Nay, more, structural elaboration due to

gains from degeneracy may be retained while degenerate structures resume their higher functions. Hence a degenerate race under more favorable environment may rank higher in evolution because of the beneficial variations due to degeneracy. The structures of the face in man are degenerate as viewed from the vertebrate type, and very early in evolution have been sacrificed to the gains of the central nervous system (Figure 2). Therefore struggles for existence between organs leave decided marks on them. The jaws and face are less marked in type with rise in evolution.

In the evolution of man from the cell he passes through all adult stages of lower vertebrates—fish and reptiles to birds and mammals. Retrogressive changes in a general way are most markedly illus-

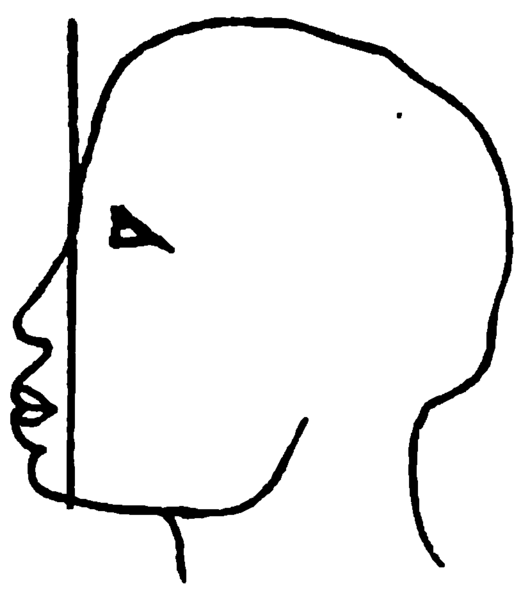

FIG. 15.

trated in plural births; here we have an atavism or return to the lower vertebrate type. Another marked retrogressive change is that in which the heart develops upon the right side—a return to the bird type. Still another is that in which the hands develop short of their normal position. There may be arrest of the bones of the arm and the hand may be given off at the elbow or shoulder. The same is true of the feet, which may become abnormally developed or given off at the knee or the hip. These are reversions to the flippers of the seal. Children "toeing in" is a return to the pre-shoe type. Shallowness of the acetabulum in children represents a type as high as the anthropoid apes.

Aristotle, 384 B. C., viewed the relations of the structures and organs to each other from the standpoint of a hypothetic law of economy of growth by which structures were sacrificed as entities to benefit the organism as a whole. Goethe in 1809 and St. Hilaire

in 1818 still further cleared this law of obscurity. Study of this revealed a struggle for existence between organs, with interaction consequent on use and disuse of structures. Camper employed this law in his use of the ideal face of the Apollo Belvidere to illustrate the gradual retreat of the jaws from lower to higher types of face (Figure 4).

The retrogressive phase of evolution, with which Camper did not deal, underlies all pathology of the face, as well as of the nose, jaws, alveolar process and teeth. The illustrations, supplementing those of Camper, portray this reverse phase where symmetry of the body as a whole is sacrificed to changes in the nose, jaws, alveolar processes and teeth so as to preserve brain gains. The facial angle

FIG. 16.

of Camper extended down below the chin, and Figure 5 represents the ideal face as portrayed by him. This illustration shows where anatomic progress ceases and the pathologic begins.

The next illustration (Figure 6), taken from photographs of patients, accurately portrays arrests of the face for the benefit of the brain. The gradual recession of the face and the forward development of the brain is a continuation of the condition shown in Figure 4 in the line of evolution. Nos. 8 and 9, Figure 6, show a return of the jaws to the lower negro type.

From the relations of this face degeneration nearly all the deformities and pathologic conditions of the head, face, nose, jaws, alveolar processes and teeth result.

One of the most common and interesting retrogressive or atavistic

developments is that including the entire head and face. The forehead recedes from the perpendicular line and the jaws protrude beyond the line. Figure 7 illustrates a Russian harlot. This type of head and face may become arrested at any period and the appearance may be that of the negro or anthropoid ape. The brain is as a rule undeveloped, taking the form of the fish, reptile, mammal, or the fetal forms of the human brain, as illustrated in Figure 8, and the individual may possess any one or all of the ethic, psychic or other degenerate qualities.

The primary skull is an extension of the vertebræ which send side outgrowths to cover the brain, as the backbone covers the spinal cord. In the lancelet it gives off two trabeculæ cranii or

FIG. 17.

front skull plates. In back the primary skull (or chondrocranium) gives off two occipital or rear skull plates and two plates midway between the trabeculæ and the occipital. These gradually close the primitive hearing apparatus, the otocysts (permanent in fish and embryonic in man), and are called periotic capsules. This primary skull is at first cartilaginous, as in sharks. With the increase in the size of the brain in biologic evolution and in human embryogeny the cartilaginous primary skull becomes insufficient to roof over the brain and gaps result. The extent of these depends upon the amount of nutriment furnished by the mother for the development of the fetus. If sufficient material is not furnished fontanelles and open spaces in the skull result. Often these spaces are filled with Wormian bones. Again, the amount of nutrition may be so scanty that the entire dome of the skull remains undeveloped, as observed

in certain monstrosities (Figure 9), which revert toward primitive vertebrates and prevertebrates.

One marked retrogressive change is excessive development of the orbits, a reversion to the lemurian type which admits of a large range of eyeball movement in watching for danger (Figure 10). The remote ancestors of the vertebrates—the ascidian, the amphioxus, the slow worm and many lizards—possessed a median unpaired eye (Figure 11), which was subsequently replaced in function by the evolution of the paired eyes. The cyclopic condition occurs among human monstrosities (Figure 12) much more frequently than among animals, Hannover claims (Sajous' Annual,

Fig. 12.

1889), but this is clearly due to the fact that human monstrosities are much more frequently recorded. Of the 120 cases I have been able to collect from literature, 56 presented other evidence of degeneracy than cyclopic conditions, and 60 had neuropathic or other defects in the ancestry. As Darcste has shown (Sajous' Annual, Vol. LV, 1892), production of a single eye, changes in the structure of the mouth, atrophy and abnormal situation of the olfactory apparatus and of the vesicle of the hemispheres, result from arrest of development and its determining influence must be exerted very early in embryogeny. This condition was discussed in a paper on Evolution of the Central Nervous System, which appeared in the Dental Digest for March, 1905, page 221.

The external ear is of all organs that most affected by degeneracy.

It is a cartilaginous organ extending from a bony base, without a bony framework for its support, and with very deficient blood supply, on account of its distance from the great blood centers, so that any defect in the nerve centers which control the local blood supply is likely to affect its nutrition. As a cartilaginous organ it has no lymphatics, which of necessity affects its growth. The sensitiveness of the ear to vasomotor changes is evidenced by the results of the extremes in heat and cold, emotional blushing and fatigue. To appreciate the retrogressive evolution observed in the ear, its embryology must be studied. I cannot enter into this discussion for want of space, so the reader is referred to Minot's Embryology.

Fig. 19

It is sufficient here to say that the ear is developed from six little buds, each having its own vasomotor system. Should the nervous system become unstable, one or all of these little points of development may become arrested—the result of which is that the external ear may not develop. One or six little protuberances may develop on the side of the head, the ear may be round, elephantine in character (Figure 13), or it may develop long and pointed (satanic) like the ear of the lower vertebrates (Figure 14), which Hawthorne gives Donatello in the Marble Faun.

In jaw evolution from an unbalanced nervous system one or both may take on a lower negro type, while the brain retains its later development. Figure 15 shows marked arrest of the face with protrusion of both jaws. Figure 16 shows marked arrest of the

face with excessive protrusion of the lower jaw. Again, in Figure 17 may be seen arrest of the face and lower jaw and excessive development of the upper jaw. A struggle is here going on between advance and retrogressive evolution.

The most interesting of all the retrogressive changes along the line of degeneracy in the human is that of change in shape of the jaw in the development of the teeth. Given an arrested upper jaw, the teeth erupt as best they can, just as a game of checkers or chess will terminate according to the first few moves upon the board. The character of the shape of the dental arch will depend upon which teeth are first developed, the cuspids or bicuspids. If the bicuspids develop first the break in the arch will occur at the weakest part, the anterior part of the mouth, and a V-shaped arch will be produced (Figure 18), a return to the reptilian type of jaw. If the cuspids develop first the break will be in the bicuspid region, which now becomes the weakest part, and a saddle arch will form (Figure 19), a return to the type of carnivora. All the other deformities are modifications of these two types, and in the mechanism of tooth eruption no other systems or shapes are possible. The jaws, traveling along the path of degeneration, return to their ancestral type—the vault of the mouth becomes low, the alveolar process short and thick, the roots of the teeth short and spread far apart.

Next to the ears the jaws and teeth (as is to be expected from the variability of these organs in allied animals) are most affected by degeneracy. This is particularly true of the vertebrates, especially the mammals, as might have been anticipated from their phylogeny or line of descent. At the head of the vertebrates is man; at the foot is the lancelet (amphioxus), most akin to the semi-vertebrates, the ascidians, which in their larval phase are higher than when adult and the life history of which excellently illustrates that potent phase of evolution—degeneracy (Ray Lankester, Degeneracy a Phase of Evolution). In the lancelet the mouth is well guarded against the intrusion of noxious substances, which have to pass through a vestibule richly provided with sensitive epithelial cells resembling the taste buds of the human mouth. There is no heart. In this the lancelet is lower than the ascidians, the insects, crustacea and many mollusks. It approximates the worms, which, despite a very elaborate vascular

system, are destitute of a heart, the function of which is performed by contractile blood-vessels. From an embryologic and morphologic standpoint, the proximate ancester of the vertebrate seems to have been a free swimming animal intermediate between an ascidian tadpole and the lancelet, while the primordial ancestor was a worm-like animal organized on a level with the starfish. The vertebrates, embryologically, develop from the amphioxus to

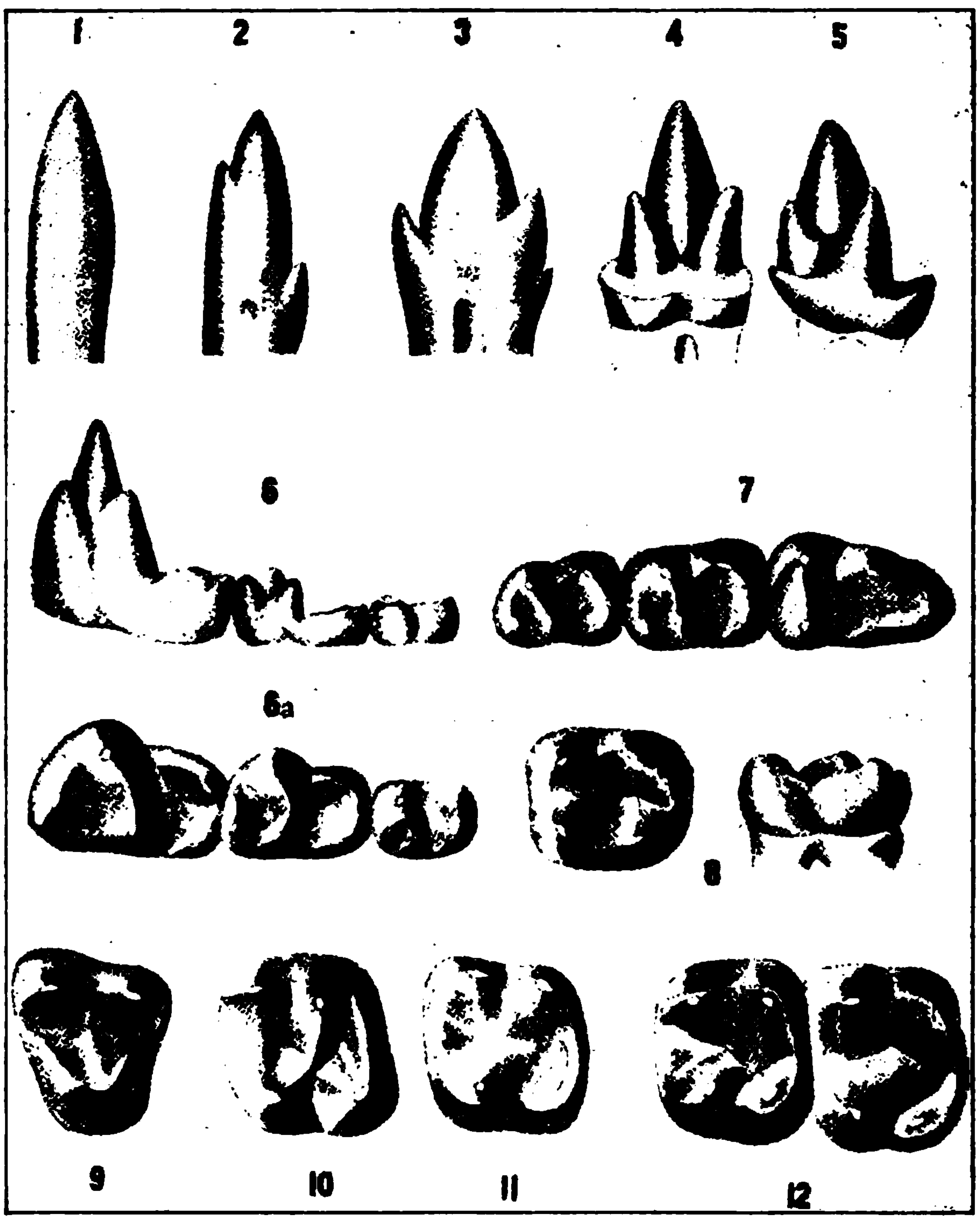

PLATE A.

the lampreys, thence to the cartilaginous fish (shark), to the amphibia (frog, toad, axolotl), to the reptiles, to the oviparous mammals (duckbill and spiny ant-eater), to the lemurs, and through forms like the pithecanthropus erectus to man.

The present study will be confined to the mammals, passing from the simple types of teeth found in that oviparous edentate, the spiny ant-eater (echidna) of Australia, to the indeciduous ances-

tors of the sloths and armadilloes and their descendants, inclusive of the dolphins and whales, whose teeth, both in fetal Greenland and adult sperm-whale, preserve this old type. The whales, it should be remembered (Haeckel, History of Creation, Vol. II, p. 242), here degenerated from the hoofed mammals to suit their environment. While as in edentates, these teeth may be few, they may also (as in the insectivorous marsupials) approximate those of the reptilia in number (sixty or seventy on a side) and characteristic location.

The evolution of this primitive tooth to the bicuspid and molar has been explained by two theories—the concrescence and the differentiation. The first, advanced by Magitot in 1877, was later advocated by Schwalbe, Carl Röse and Kurkenthal. The last

PLATE B.

was offered by Osborn and Cope. The concrescence theory (Talbot, Degeneracy, Its Causes, Signs and Results) is bringing together several isolated teeth and forming bicuspids and molars. A number of conical teeth in line as they lie in the jaw of the whale represent primitive dentition. In the course of time a number of these teeth would become clustered together in such manner as to form the four cusps of a human molar, each one of the whale-tooth points taking the place of one of the cusps of the mammalian tooth—in other words, by a concrescence four teeth would be brought into one so as to constitute the four cusps of the molar crown. Vertically succeeding teeth might also be grouped. Now what evidence is there in favor of this theory and what is there against it? First, there is this, that all primitive

types of reptiles from which mammalians have descended, and many existing mammals, as we have noted, have a large number of isolated teeth of a conical form; second, we find that by a shortening of the jaw the dental fold or embryonic fold, from which each of the numerous tooth caps is budded off in the course of development, may be supposed to have been brought together in such manner

FIG. 20.

that cusps which were originally stretched out in line would be brought together so as to form groups of a variable number of cusps, according to the more or less complex pattern of the crown.

The differentiation theory is the addition of cusps to the conical tooth. Going back over ten millions of years in the Triassic we find the mammalia, or the first animals which we can recognize

FIG. 21.

as mammalia, possessing conical, round, reptilian or dolphin-like teeth. There are also some aberrant types which possess complex or multituberculate teeth.

"These teeth begin to show the first traces of cusp addition. In Plate A, Figures 1 and 2, the teeth of the dromatherium of the coal beds of North Carolina occur on the sides of the main cone cusps or rudimentary little cusps. On either side of the main cone are

two small cusps. In the same deposit occurs another animal represented by a single tooth (Plate A, Figure 3) in which these cusps are slightly larger. These cusps have obviously been added to the side of teeth and are now growing. In teeth of the Jurassic

FIG. 22.

period, found in large numbers both in America and in England, but still of very minute size, are observed these same three cusps. These cusps have now taken two different positions; in one case

FIG. 23.

they have the arrangement presented in Plate B. The middle cusp is relatively lower and the lateral cusps are relatively higher, in fact, these cones are almost equal in size. These teeth are termed triconodont, as having three nearly equal cones. But associated

with this is the spalacotherium, the teeth of which are represented in Plate A, Figure 4. Here is illustrated the transformation of a tooth with three cusps in line into a tooth with three cusps forming a triangle. Here the primitive cusp is the apex of a triangle

A

Fig. 24.

of which the two lateral cusps are the base. This tooth, in this single genus, is the key of comparison of the teeth of all mammalia, and by this can be determined that part of a human molar

Fig. 25.

which corresponds with a conical reptilian tooth. This is the triangle stage, and the next is a development of a heel or spur upon this triangle (see the amphitherium, Plate A, Figure 5).

The opossum still distinctly preserves the ancient triangle. Look at it in profile, inside or top view, and see that the anterior part of the tooth is unmodified. This triangle is traceable through a number of intermediate types.

"In Miacia (Plate A, Figure 6), a primitive carnivore, is a high triangle and a heel; looked at from above (Plate A, Figure 6a)

Fig. 26.

the heel is seen to have spread out so that it is as broad as the triangle. The three molars of this animal illustrate a most important principle, namely, that the anterior triangle portion of the crown has been simply leveled down to the posterior portion. These three teeth form a series of intermediate steps between a

Fig. 27.

most ancient molar and the modern molar of the human type, and the second tooth is half way between the first and the third. The second molar, seen from above, has exactly the same cusps as the first, so it is not difficult to recognize that each cusp has been directly derived from its fellow. The third tooth of the

series (Plate A, Figure 7) has lost one of the cusps—of the triangle. It is now a tooth in which only half the triangle is left on the anterior side and with a very long heel. That tooth has exactly the same pattern as the human lower molar (Plate A, Figure 8), the only difference being that the heel is somewhat more

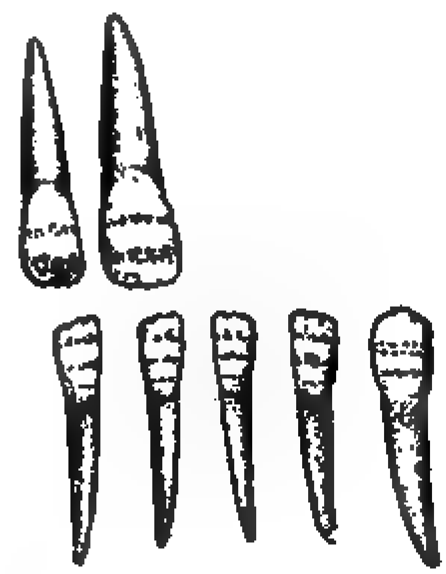

Fig. 28.

prolonged. These teeth belong to one of the oldest fossil monkeys, anaptomorphus. Human lower molars not infrequently have five cusps instead of four, and the fifth always appears in the middle of the heel or between the posterior lingual and the posterior buccal. This occurs in monkeys and other animals, but

Fig. 29.

no record exists of the ancient anterior lingual reappearing. The human lower molar, with its low, quadrituberculate crown, has hence evolved by addition of cusps and by gradual modeling from a high-crowned, simple-pointed tooth."

Human teeth are of excellent service in the initial determination of retrogressive evolution in the child, and for this purpose they should be studied from the first evidence of their development until they are all in place, which occurs normally in most cases by the twenty-second year. Man in the present stage of evolution has twenty teeth in his temporary and thirty-two in his permanent

Fig. 30.

set. Any deviation in number is the result of embryonic change occurring between the sixth and fifteenth week for the temporary teeth and the fifteenth week and birth for the permanent. The germs of teeth which erupt late in life and are called third sets of necessity appear before birth and are completely formed at the beginning of the second year, although they remain protected in the jaw until eruption. More than twenty teeth in the temporary or thirty-two in the permanent set are hence an atavistic ab-

Fig. 31. Fig. 32. Fig. 33.

normality. From the maxillary and dental standpoint man reached his highest development when well-developed jaws held twenty temporary and thirty-two permanent teeth. Decrease in the number of teeth meant, from the dental standpoint, degeneracy, although it might mark advance in man's evolution as a complete being.

In the New Mexican Lower Eocene occur monkeys like the lemuravus and limnotherium, each the type of a distinct family. The lemuravus, most nearly allied to the lemurs, is the most generalized monkey yet found. It has forty-four teeth in continuous

series above and below. The limnotherium, while related to the lemurs, has some affinities with the American marmosets. These solved the problem of the origin of extra teeth (known as supernumeraries) that sometimes occur in man, and demonstrated that man during his evolution from the lowest monkey lost twelve teeth.

FIG. 84.

These supernumerary teeth are a return to the lemurs. They assume two forms—they either resemble the adjoining teeth or are cone-shaped. While they are rarely exactly counterparts, every tooth can be duplicated (Talbot, Irregularities of the Teeth), as the following illustrations show. Figure 20 shows fairly well de-

FIG. 85.

formed duplicate central incisors, the normal incisors being outside the arch. They are crowded laterally by the large roots of the supernumerary incisors. Figure 21 shows an extra right upper lateral in a temporary set, which is always found in the dog, and extra laterals are often seen in the permanent set. Figure 22

illustrates a jaw without laterals. Figure 23 shows normally developed supernumerary cuspids which are all grouped together upon the right side, the bicuspids being duplicated on either side; indeed, all the teeth but the molars are duplicated, and are a return to the Port Jackson shark, the dogfish, etc. Figure 24. Figure 25 shows supernumerary third molars easily demarcated from the normal molars. The teeth which fail to approximate their normal neighbors assume the cone-shape of the primitive tooth.

The fact that the cone-shaped tooth, as a rule perfect in construction, is found everywhere in the jaw, but especially in the

FIG. 36.

anterior and posterior part of the mouth, is of much value in outlining tooth and jaw evolution, especially in the degeneracy phase. The upper jaw, being an integral part of the skull and fixed, is of necessity influenced by brain and skull growth, hence degeneracy is more detectable in it than in the lower.

The evolution of the jaw is toward shortening in both directions, and this shortening will continue so long as the jaw must be adjusted to a varying environment. The jaw of man having origi-

FIG. 37.

nally contained more teeth than at present, lack of adjustment to environment produces, from the shortening, degeneracy of the jaw and atavism of the teeth. While these may coincide with the general advances of the individual, they indicate that he is not yet adjusted to his new environment. The shortening of the upper jaw causes supernumerary, cone-shaped teeth to erupt in mass at the extreme ends of the jaw.

Figure 26 shows three supernumeraries—a cone-shaped tooth between the centrals; the laterals and cuspids out of position; the left permanent lateral at the median line; another cone-shaped tooth in the vault, and the supernumerary left lateral in place. As many as eight are at times to be observed in the anterior vault. These teeth are most often found in connection with the third molars, usually on a line with other teeth and posterior to the last molar. Supernumerary teeth are not confined to these localities, but may be observed at any point in the arch. The primitive cone-shaped tooth is rarely observed in the lower jaw, and in thirty-five years' practice I have not seen a case. The mobility of the lower jaw prevents that maladjustment to environment present in the upper. The continual shortening of the jaw in both

Fig. 38.

directions causes the third molars frequently to wedge in between the angle of the jaw and the second molars, so that eruption is difficult, if possible.

The third molar is often absent in the English-speaking and Scandinavian races, and in forty-six per cent of six hundred and seventy patients it was missing. Frequently its development is abortive, and this tooth seems destined to disappear in the struggle for existence. It is more frequently absent from the upper than the lower jaw, and when missing or badly developed the jaw is smaller, and often irregularities, nasal stenosis, hypertrophy of nasal bone and mucous membrane, adenoids and eye disorders coexist. In Figure 27 both third molars are seen to be missing.

Anteriorly the lateral incisors are most often wanting, and fourteen per cent of them were wanting in six hundred and seventy patients. In the process of evolution man has lost one lateral upon either side of the mouth, and the second lateral also seems destined to disappear? Not infrequently does it occur that centrals, cuspids, bicuspids and even molars are absent, even their germs not being detectable, which is a sign of advance in evolution. Absence of the teeth indicates lack of development of germs,

Fig. 39.

due either to heredity or to defective maternal nutrition at the time of conception or during early pregnancy.

Crescent-shaped, bituberculate, trituberculate, and all deformed teeth tend to the cone-shape. The malformation of these teeth results from trophic change in dentin development before birth. It consists in dwarfing and notching the cutting and grinding edges of the second set, a familiar example of which is seen in the so-called Hutchinson's teeth, usually referred to a syphilitic etiology. Hutchinson's position has, however, been more strongly stated than his words justify, since he admits that in at least one-tenth of the cases luetic etiology could be excluded (American System of Dentistry). Lues plays only the part of a diathetic state

profoundly affecting the maternal constitution at the time of dentin development. While these teeth may be due to the secondary results of lues, they do not demonstrate their luetic heredity.

In Figure 28 (American System of Dentistry) are seen the teeth of an individual affected with very marked constitutional disease. The degrees of pitting will depend as a rule upon the severity of the constitutional disorder, but in the case just cited, although nutrition was but slightly disordered, each tooth showed a tendency to assume a cone-shape. Not infrequently cavities are extended through the tooth. The cusps of the (permanent) first molars calcifying at the first year are usually attacked also and

FIG. 40.

arrested in development, producing the cone-shape. These data, together with the dates of eruption of the temporary and permanent teeth, furnish an absolute basis for calculation as to excessive or arrested development of tissue.

Figure 29 shows a very degenerate jaw with cone-shaped malformed bicuspids. The right lateral is missing, the cuspids are erupting in the vault, and the arch is assuming a V-shape. The jaw as a whole shows marked arrest in development.

Figure 30 shows Hutchinson's teeth. Were the first molars visible they would present marked contraction of the outer surface, with a malformed center—a tendency to take the cone-shape.

Figures 31, 32, 33, and the molars in Figure 34 exhibit malfor-

mations, and assume the cone-shape and the center frequently associated with this type of teeth. The coincidence in form between Hutchinson's and malformed teeth and those of the chameleon demonstrates that tropho-neurotic change produces atavistic teeth.

Figure 35 illustrates the tendency of human bicuspids to rotate one-fourth of the way around when there is no antagonism, thus again demonstrating the atavistic tendency toward the teeth of the chameleon.

Figure 36 (Smale and Colyer) exhibits extreme atavism; all teeth anterior to the molars are cone-shaped; the third molars are

Fig. 41.

missing and would probably never have erupted. In Figure 37 (Smale and Colyer) appears more marked atavism; the upper and lower anterior teeth are cone-shaped, and the superior first bicuspid exhibits a tendency thereto; the right superior second bicuspid, right inferior second biscuspids, and the second and third molars are missing. The same condition probably exists on the left side.

Fig. 42.

Fig. 43.

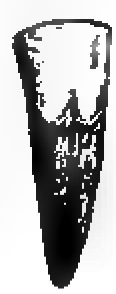

Fig. 44.

Fig. 45.

Fig. 46.

The space in the upper jaw is due to the insufficient width of the teeth. Alternation of teeth in the upper and lower jaws is a reptilian feature. Figure 34 furnishes an excellent illustration of the principles previously advanced.

In degenerate jaws the influence of the factors of the differen-

tiation theory are also demonstrated. Every tooth in the jaw at one point or another may display rudimentary cusps. On the incisors they are always to be found on the lingual surface. Figure 38 illustrates the centrals with two rudimentary cusps, the laterals with one, and the cuspids with one. Figure 39 represents cusps upon the lingual surfaces of the molars. The cuspids are not unlike the lower bicuspids with a rudimentary lingual cusp.

FIG. 47.

Thompson remarks that there is a gradation from the central incisors toward the bicuspids in evolution. This grading of form is not observed in the passage from the cuspid to the bicuspid in man, but it should be remembered that the cuspid often presents a cingulum on the lingual face that inclines it toward the bicuspid forms in lower mammals, like the mole, and that the first bicuspid

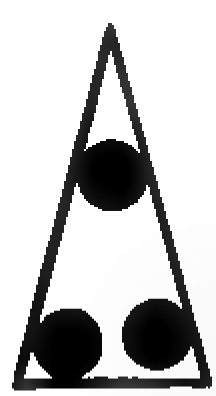
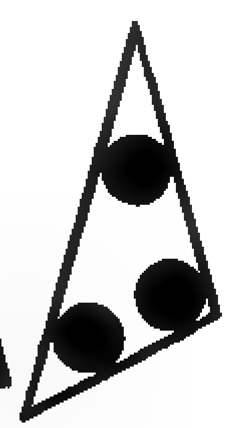

FIG. 48. FIG. 49.

is then more cuspidate in form, the inner tubercle being much reduced. This tubercle is variable and even erratic as to its position; it appears as far forward as the centrals and is often present on the lingual face of the laterals of man. The lingual tubercle is very constant on the first bicuspid of man and is as well developed as the buccal, but in some lower forms, as the lemurs, it is quite deficient, and it attains the highest development only in the

anthropoids and man. Considering these stages of development, the grading from the cuspid to the bicuspid forms was more gradual in the earlier species than in the later, where the individual teeth have taken on special development (*Cosmos,* May, 1894).

The skull of a degenerate girl, who died from tuberculosis at thirteen years, has among other stigmata a cusp on the external surface of a right inferior cuspid. This is a decidedly strong point in favor of the differentiation theory. Another strong example in its favor occurs in Figure 40 (Smale and Colyer), where every tooth is present and a most remarkable display of cusps occurs. The cusps upon the cutting and grinding edges are not obliterated. Commencing with the left superior central incisor, three cusps are present with a rudimentary palatine cusp. The laterals also show three cusps, while the cuspid has two very distinct ones. The first and second bicuspids have tubercular cusps, they being in line. The buccal cusps upon the molars vary from two to three and are still in position, but the palatine cusps are worn away. The same is the case upon the opposite side, except that the cuspid has cusps that have fused together, leaving a small projection upon the mesial side and a rudimentary palatine cusp. The cusp upon the third molar is lost. In another case (Figure 41, Smale and Colyer) the primitive cone teeth are seen trying to shape themselves into incisors. The lateral incisors, cuspids and bicuspids are still cone-shaped; the first permanent molar is fairly well formed, while the second molars are still in a primitive condition. The points made by Osborn are fully demonstrated in the last two illustrations—namely, the triangular-shaped crowns and the leveling of cusps.

There is abundant evidence to show that degenerate teeth unite in twos, threes, fours and fives, as indicated in the concrescence theory, and these single cone-shaped teeth grow together and form bicuspids and molars. The germs of any two normal teeth may intermingle and unite; not only are the crowns found united with separated roots, but crowns and roots are united throughout. Figures 42 and 43 show a superior central and lateral incisor joined together throughout the entire length of crown and root. Figure 44 illustrates two lower incisors which are united throughout. Figure 45 shows a cuspid with two roots. Dr. George T. Carpenter of Chicago has a right superior second bicuspid with three well-formed

roots. Figure 46 illustrates two bicuspids united at the crowns. It is not uncommon to find three molars united together, as the second, third and supernumerary. Dr. C. V. Rosser of Atlanta, Georgia, has two small molars and a supernumerary cuspid perfectly united from crown to root, and these three are also united to the roots of a well-formed molar. Thus we see the concrescence theory is fully established.

A condition of molar tooth occasionally observed in America, but more often in England, Scotland and Ireland, is that where the crown is flattened from side to side (Figure 47) and the roots are nearly or quite on a line; instead of being normal, like Figure 48, they stand like Figure 49 (*Dental Review*). The third molar is usually affected. These teeth are usually found in degenerate jaws, and like most abnormalities observed in same they are atavistic, reverting in crown and roots to the original triconodont type with cusps and roots in line. The roots are sometimes separated, containing two or three, or there may be only one flattened upon the sides.

Dr. S. H. Guilford was the first to call attention to this particular anomaly, in the American System of Dentistry, page 416, under the heading "Compressed or Flattened Crowns." He says, "Among the anomalies of tooth structure or formation this one is very rare. The crowns of this character are flattened in the antero-posterior direction, so that their diameter transversely of the jaw is by far the greater one. The fissures or sulci, instead of presenting the usual form, are distorted and sigmoid in shape, corresponding with the long diameter, while the cusps resolve themselves into narrow ridges somewhat after the manner of the molars of the ruminantia. The third molars of the superior arch are the ones usually affected, although the writer has seen one case in which the superior first molar presented the same condition."

William Booth Pearsall of Dublin, Ireland, called attention to this abnormality at the 1888 meeting of the Royal College of Surgeons, Ireland (*Dental Review,* January, 1899). The question arose in connection with extraction, since there was difficulty in seizing the tooth with the forceps because of the shape of the crown and roots.

In degeneracy is peculiarly well illustrated the operation of the law of economy of growth, producing arrested and excessive development as seen in edentulousness and excessive dentition. As

Darwin points out, hairless dogs have imperfect teeth, the dermic defects affecting the animal as a whole, and other organs profiting by the deficiencies of the hair and teeth. In most cases of hairy men there is, as Magitot remarks, defective or irregular dentition. Here the struggle for existence (which has been between the teeth, which are derived, as elsewhere shown, originally from the skin) is now between the teeth and hair. In the case reported by Thurman, a man fifty-eight years of age, who was almost devoid of hair all his life, possessed only four teeth. There was absence of sensible perspiration and tears. The skin was peculiar in its delicacy, thinness, softness and absence of pigmentation. The hair on the crown of the head and back was very fine, short and soft, and in quantity about like that of a three months infant. A similar condition existed in his cousin-german. In a case reported by Williams, a fifteen-year-old girl had scarcely any hair on the eyebrows or head and was destitute of eyelashes. She was edentulous and had never sensibly perspired. "Jo-Jo," the famous "Dog-Faced Boy," had very defective teeth. Borelius found atrophy of all the dental follicles in a woman of sixty who had never possessed any teeth. Fanton-Touvet saw a boy of nine who had never had any teeth. Fox reports a woman who had but four in both jaws. Tomes cites several similar instances. Hutchinson reports a child who was perfectly edentulous as to temporary teeth, but whose permanent teeth duly and fully erupted. Guilford describes a man of forty-eight congenitally and permanently edentulous, who had no sense and was almost without taste. The surface of his body was covered with fine hairs. He had never had visible perspiration. Otto observed two edentulous brothers (Gould's Anomalies).

Excessive dentition shows itself in many varieties, especially those which constitute a return to the polyphyodont types of the lower vertebrates. O. Hildebrand of Gottingen, Germany, in 1889 reported (Medical and Surgical Reporter, July 15, 1890) the case of a child of twelve which after various operations had been relieved of about two hundred teeth of various sizes. Two years later (July, 1891) the patient came under observation at the Gottingen Surgical Clinic. Both sides of the lower jaw were much thickened, as was also the right side of the upper jaw. There were found seventeen teeth, part of them normally developed, others in an undeveloped condition, and their position was deviated and irregular. From the upper and

lower jaw there were again some masses removed (which had the same conformation as those extracted in 1889) which represented about one hundred and fifty teeth. There were also found two round glassy bodies about the size of two peas, which upon microscopic investigation showed tooth structure. This is a return to the polyphyodont type from arrest of development very early in fetal life. Beside the supernumerary teeth elsewhere described, arrests of development producing excessive dentition may evince themselves in double rows and in anomalous positions. In the Paris Dental School Museum are several deciduous teeth, both of the superior and inferior maxilla, fused together. Bloch cites a case where there were two rows of teeth in the superior maxilla. Hellwig has observed three rows of teeth. The Ephemerides contain an account of a similar anomaly. Teeth have been found, as Gould points out, in the nose, orbit, palate, and exceptionally, as in a case reported by Carver, they may grow from the lower eyelid. In Carver's case the number of deciduous teeth was normal. Although the supernumerary tooth was a cuspid, it had a somewhat bulbous root.

Arrest of development proceeding from a check at the senile period of fetal life may evince itself in senility of the alveolar process, as in a case reported by Bronzet, where a child of twelve had but half its teeth, the alveolar process having receded as in old age. Such arrest of development may also produce polyphyodont conditions in the human being. Catching reports (Boston Medical and Surgical Journal, July 10, 1887) the case of a girl who had all her teeth at six months and shed them at nine. At fifteen months she had a full set once more, and in six weeks these were shed. At two years and a half she again had a full set, which remained until her fourth year, when came another. This remained until another set began to erupt at eleven and became the permanent set complete at fifteen. This was a reversion to the snake and elephant.

The homology of the dental tissues with the tissues of the true skin, already pointed out, and the special identity of the enamel with the extra vascular appendages, render it certain, as Dr. A. H. Thompson points out (*Dental Cosmos*, Vol. 19, p. 237), that they are governed by the same laws, subject to the same influences and possess the same phenomena of character as the allied tissues. Community of origin and similarity of structure and nature necessarily establish identity in the manner of life, in the methods of maintain-

ing life, with its varied phenomena of similarity of service rendered to the economy, and in the process of dissolution and expulsion from the system. The relationship and homology of the teeth with the skin and its varied appendicular productions are established by demonstration. This can well be true and yet have them preserve the unity of character, which they do not fail to do. Teeth, spines, scales, dermal plates, nails, hair, bristles, horns, hoofs, etc., as varied in form and apparent purpose as tissues can well be, are yet closely related in structure and function, with variations of course within certain limits.

The enamel consists of calcified epithelial cells elaborated for the endurance of an appointed work and service in the economy. Enamel, like epithelium and corneous structures, yields, as A. H. Thompson remarks, keratin. In structures so unstable in evolution as the teeth, arrest of development would tend to produce for this reason a reversion to horny structures in place of enamel. Indeed, this occurs physiologically in certain vertebrates. In that oviparous mammal, the duck-bill, true teeth appear in the embryonic state, to give way later, by what Thompson calls suppressive economy or the degenerative results of the struggle for existence between the organs, to horny structures. The same condition must have appeared when the toothed birds began to lose their teeth in the Tertiary. Arrests of development in man may therefore produce what is seemingly a reversion to this condition of the duck-bill. As has already been pointed out, neurotic cases occur in which, from arrests of development, there is very little enamel upon the teeth.

It is not uncommon to occasionally find an adult with large, well-developed jaws, containing thirty-two teeth with broad short crowns, short-spreading roots, low vaults, short alveolar processes, dense enamel and no decay. A tooth brush has never been used, there is no tartar, and the gums are healthy. This is a marked atavistic illustration.

The following books and articles are recommended for reference:

1. Brains of Criminals, C. K. Mills, Journal of Nervous and Mental Diseases, 1886.

2. Genius not a Neurosis, Kiernan, Alienist and Neurologist, 1892.

3. Transformation of Heredity, Kiernan, Medicine, 1898.

4. Degeneration Stigmata as the Basis of Morbid Suspicion, Kiernan, Alienist and Neurologist, 1898-1901.

5. Odor in Pathology, Kiernan, Doctor's Magazine, 1900.

6. Maternal Impressions, Kiernan, Medicine, 1900.

7. Heredity, Kiernan, Medical News, July 5, 1901.

8. Intrauterine Periods of Stress, Kiernan, Medicine, 1901.

9. Mixoscopic Adolescent Survivals, Kiernan, Alienist and Neurologist, 1903-1905.

10. Somatic Etiology of Insane, E. C. Spitzka.

11. Adolescence, Stanley Hall.

12. Man and Woman, Havelock Ellis.

13. The Criminal, Havelock Ellis.

14. Psychology of Sex: Sexual Selection, Havelock Ellis.